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CHARLES MOHR AND *PLANT LIFE OF ALABAMA*[1]

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Charles Mohr (1824-1901) was one of the foremost botanists of the southern United States during the late nineteenth century. His stature as an early southern botanist is overshadowed only by that of A. W. Chapman, author of numerous editions of the *Flora of the Southern States*. Like Chapman, Mohr was both a resident botanist and, for the most part, an amateur botanist. His 40 years of study centered in Mobile, Alabama. These studies culminated in the publication shortly after his death of *Plant Life of Alabama*, which remains as the only published attempt to describe the flora of the entire state.

During an investigation of the contents of the herbarium of the Geological Survey of Alabama (Mohr Herbarium), I realized that very little was known about either Mohr's life or his scientific works. It is the purpose of this paper to examine the life of Mohr, his scientific works, and the circumstances leading to the publication of *Plant Life of Alabama*.

Facts contained in the following biographical sketch were drawn largely from Hoffmann (1887), Scribner (1893), Smith (1901b, c), and Tracy (1901). Supplementary facts were garnered from less extensive works and from letters exchanged between Mohr and Eugene Allen Smith, then State Geologist of Alabama. These letters are stored in the Special Collections of the Amelia Gayle Gorgas Library, The University of Alabama. The sources for other letters cited are included with the references.

SKETCH OF THE LIFE OF CHARLES MOHR

Charles Theodore Mohr (originally, Karl Theodor Mohr) was born December 28, 1824 in Esslingen, Württemberg, Germany, the son of Louis M. and Dorothea Mohr. He spent his youth in Esslingen and at the Cloister Denkendorf, where his father had obtained an interest in a chemical factory. His early interest in plants is linked to his great uncle, who was a pensioned forester of the district, and to a local pastor who was interested in nature studies.

In the fall of 1842 Mohr entered the polytechnic school of Stuttgart, where his studies concentrated on chemistry and natural sciences. These studies were supplemented by weekend geological and botanical excursions, during

[1] This paper is adapted from a thesis submitted to The University of Alabama in partial fulfillment of the requirements for the degree of Master of Science.

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Fig. 1. Portrait of Charles Mohr, from Smith (1901c).

which Mohr made notations of the geological formations and plant associations observed (Hoffmann 1887).

During the summer of 1845 Mohr was assigned to arrange the herbarium duplicates of the institute and to distribute these specimens to the secondary schools in the area. While pursuing this work he met August Kappler, who was engaged in the collection of natural history specimens from Dutch Guiana (Surinam). In November, 1845, he left with Kappler on an expedition to explore the headwaters of the Surinam River. The party arrived at the coast of Guiana near the middle of March, 1846. Mohr was only able to spend seven months in South America, however, as an attack of dysentery and fever confined him to camp—the first attack of the ill health that would always plague him. According to Robinson (1903), Kappler "heartlessly left him behind, to live or die, while he [Kappler] pushed onward in his ventures."

In March, 1847, Mohr returned to Europe and soon found employment as a chemist in Brunn, Austria. However, the political turmoil of 1848 forced the business to close, while it also eliminated Mohr's hopes for a higher education (Mohr 1879). At this time Mohr and his older brother immigrated to the United States, arriving in New York in October, 1848. After a short stay in Philadelphia, they moved on to Cincinnati, where Mohr again found employment as a chemist.

In March, 1849, Mohr set off with about 50 other young men as a member of the "Cincinnati Gold Mining and Trading Company" to seek his fortune in the gold fields of California. After outfitting in Independence, Missouri, the group headed westward in mid-April with 10 wagons. The journey became increasingly difficult, and at Fort Laramie many belongings had to be abandoned. At this point Mohr traded his gun to a Sioux Indian in exchange for a pack horse to carry his books and plant collection (Hoffmann 1887).

After splitting into parties of 10, the group reached Fort Hall in July. It was here that the wagons and baggage had to be given up, and Mohr dumped his books and plant collection into the Snake River. The parties reunited in Sacramento near the middle of August, after a trip totaling 110 days.

Mohr and his party met with some success at placer mining in California. However, again, in the spring of 1850 Mohr fell ill to mountain fever and decided to return east. He and some others left the mines in September, 1850, for San Francisco, where they booked passage for Panama. While traveling across the Isthmus, the party's pack mules—along with Mohr's collection of California plants—were stolen, and Mohr again fell ill to fever. He finally reached New Orleans and traveled to Cincinnati, arriving toward the end of December, 1850. He and his brother purchased a farm in Clark County, Indiana, and he married Sophie Roemer on March 12, 1852.

Various attacks of rheumatism soon convinced Mohr that he was not suited for a farmer's life, so he established himself in the drug business in Louisville,

Kentucky. Here he became acquainted with the bryologist Leo Lesquereux and resumed his botanical studies, concentrating on the mosses. However, again his health failed, and Mohr was advised by his physician to move to a warmer climate. He moved first to Louisiana, then to Vera Cruz, Mexico, and in early 1857 established himself in the highlands of Mexico between Cordoba and Orizaba. Again, political turmoil forced him to move on, and he arrived in Mobile, Alabama, in the autumn of 1857.

Mohr remained in Mobile for the next 40 years, where he founded a successful drug business. This business suffered much during the Civil War, during which Mohr was employed by the Confederate government in the manufacture of drugs from native resources and the testing of medicines smuggled in from Europe. He remained in the drug business until 1892, when he turned the management over to his son, Charles A. Mohr. Mohr lived in Mobile for eight years following his retirement, and Schenck (1955) describes him during this time as "an old and broken man, who spoke English with a Wurtembergian accent, although he had lived in the United States for forty years."

In March, 1900, Mohr and his wife moved to Asheville, North Carolina, both to provide a change in climate and to give him the opportunity to work in the Biltmore Herbarium. He died in Asheville on July 17, 1901.

SCIENTIFIC WORKS OF CHARLES MOHR

The scientific works of Charles Mohr can be summarized as being scientifically accurate but leaning toward the practical and economic aspects of botany, agriculture, and geology. In his biographical sketch, Smith (1901c) states:

> From about 1878 the results of these [Mohr's] scientific investigations began to be made public in a series of articles, at first practical and economic only, afterwards more strictly scientific and specialized, but always directed toward the imparting of useful knowledge to his fellowmen. As with his collections, primarily intended to illustrate some feature of our natural resources, they grew in breadth and completeness until they became illustrative of monographs.

These interests and goals adequately sum up the scientific works of Charles Mohr.

Tracy (1901) states that Mohr's first scientific paper was a lecture presented in Vienna in 1847 on the geology of the Surinam region. Like most of his peers, Mohr was interested in other aspects of the natural sciences besides forest botany, and he included mineralogy, geology, and conchology among his interests. He contributed a short paper concerned with both geology and anthropology to the 1881 Smithsonian Institution *Annual Report* (Mohr 1883a).

Smith (1901b) states that during the summer of 1876 Mohr examined the gold reserves of the metamorphic region of Alabama, and that the floristic notes that he took during this study were published in Berney's *Hand Book.*

Smith further states that the collection of minerals from this trip was exhibited in Mobile in 1876 and in Atlanta in 1881, and that the collection was eventually sent to the U. S. Department of Agriculture. A report by Mohr on the economic geology of Alabama was issued in 1878.

Mohr's earliest contributions to North American botany involved collections of mosses and ferns. As mentioned previously, Mohr met the bryologist Leo Lesquereux while at Louisville, and Scribner (1893) states that Mohr "greatly assisted Lesquereux and James by furnishing material for their work on the mosses of North America." Smith (1901b, c) adds that Mohr's collection of ferns of southern Alabama was sent to Daniel C. Eaton and incorporated into his *Ferns of North America.* Mohr also published five short papers on bryology in the *Bulletin of the Torrey Botanical Club* in 1874. Although he published no more on the subject, Mohr's interest in cryptogams must have continued throughout his life, as F. S. Earle read a paper by Mohr on the mosses of Alabama to the 1899 Columbus botanical meetings (Anonymous 1899).

Mohr's interests always leaned toward the practical side of science, and these interests brought him to perform numerous investigations for the Grange on methods of improving the soils of Alabama. These investigations included the assessment of the value of various types of wood ashes, pine straw, leaves, and cotton seed hulls as soil builders. The results of these experiments were never published.

Another primary interest of Mohr's was the examination of plants introduced to North America on ships' ballast. By living in the international port of Mobile, Mohr was able to comb the ballast grounds for newly introduced species. His preliminary findings were published in the *Botanical Gazette* in 1878, and many detailed notations of plant introductions and dispersals are found in *Plant Life of Alabama.* Many plants collected by Mohr and deposited in the Mohr Herbarium are simply marked "ballast ground" and include the date of their first introduction.

Botany, however, was a recreational activity for Mohr, as his training was that of a chemist and his business was based on drugs. He combined his vocation and avocation in a number of articles in the *Proceedings of the American Pharmaceutical Association,* as well as in the German *Pharmaceutische Rundschau.* His "Medicinal Plants of Alabama" was published both in English and in German (Mohr 1890a, b). His knowledge of medicinal plants was well known, and in 1897 Mohr was appointed to the U. S. subcommission of the Pan-American Medical Congress to study the American medicinal flora (Anonymous 1897).

A quick glance at Mohr's publications indicates that his interests lay primarily in forestry and forest products. These interests led to his many popular articles published in *Garden and Forest* and in the *Rundschau,* as well as addresses to various meetings, such as the American Cotton Planters Association (Mohr 1883c). He was in charge of several natural history exhibi-

tions at regional expositions, including the New Orleans exposition of 1884. Mohr (1883b) published a list of the natural resources displayed at the Louisville exhibition for the Louisville and Nashville Railroad which Scribner (1893) described as "one of the few papers of its kind which possesses real scientific merit."

In 1880, Mohr was contacted by Charles Sprague Sargent to investigate the forests of the Gulf states. Although he expressed concern about receiving credit for his work (Mohr 1882a), Mohr's results were published in the ninth volume of the Tenth United States Census. This work marked the beginning of a long association with the Department of Agriculture, which culminated in the writing of a series of extensive monographs on southern trees of economic importance. One such report (Mohr 1896a) treated the southern pines and included a study on wood anatomy by another author. "Notes on the Red Cedar" was published posthumously. Smith (1901b) reported that at the time of Mohr's death the monographs on Bald Cypress and Juniper were also in press, and that one on the oaks had been completed, but none of these papers has ever been published.

Mohr was a member of many pharmaceutical and scientific associations, and he played an active role in most of them. As enumerated by Tracy (1901), Mohr was an honorary member of the state pharmaceutical associations of both Ohio and Louisiana, and is listed as a member of the American Pharmaceutical Association from 1871 onward (Anonymous 1885). Mohr's letters indicate his participation in two revisions of the *Pharmacopeia* (Mohr 1890c, 1900a). As for botanical associations, Mohr was a corresponding member of the Philadelphia Academy of Natural Sciences, the Massachusetts Horticultural Society, and the Torrey Botanical Club, and a fellow of the American Association for the Advancement of Science. He is known to have presented papers to the 1891 and 1892 meetings of the latter Association (Anonymous 1891, 1892).

Mohr's most active participation, however, was in the field of forestry, and especially as a member of the American Forestry Congress. At the Cincinnati meeting in April, 1882, he presented a paper, "The Southern Pine," and was appointed to chair a committee "to report upon Forest Fires, and the Injuries to Forests by Cattle" (Anonymous 1882a). At the Montreal meeting in August, 1882, he was appointed temporary treasurer and a member of three committees, and also presented a paper (Anonymous 1882b).

Through his many activities, Mohr was able to meet and maintain contact with many of the prominent scientists of his day. He corresponded frequently with N. L. Britton, largely concerning questions of nomenclature and the identification of sedges, and these letters can be found in the archives of the New York Botanical Garden. The Smithsonian Institution Archives contain his many letters to G. R. Vasey, J. N. Rose, S. M. Tracy, and C. L. Pollard. In letters to Smith, Mohr (1882b, c) mentioned meeting A. W. Chapman while working in Washington and meeting George Engelmann

while staying with Sargent in Massachusetts. His correspondence and consultation with Chapman continued until the latter's death and is related in a biographical sketch of Chapman (Mohr 1899a). In a different letter, Mohr (1898) mentioned that Gifford Pinchot hoped to meet him, and his association with another prominent forester, George B. Sudworth, is described in an earlier publication (Mohr 1892a).

PUBLISHED WORKS OF CHARLES MOHR

The following is a list of the published works of Charles Mohr. Fifty-five entries are listed, and, although it is hoped to be complete, additional works may be found, especially in German journals. This list does not include reprintings or re-editions, nor does it include the many abstracts listed by Harper (1928). Journal title abbreviations follow Lawrence et al. (1968). An asterisk (*) indicates a work that I have not seen.

Additions to the bryology of the United States, I-V. 1874. Bull. Torrey Bot. Club 5:5-8, 12-13, 34-35, 49-50, 50-51.

On *Pynanthemum linifolium* and its chemical constituents. 1877. Proc. Amer. Pharm. Assoc. 24:513-516.

Foreign plants introduced into the Gulf states. 1878. Bot. Gaz. (Crawfordsville) 3:42-46.

*Economic geology of Alabama: report on the minerals of Alabama, exhibited at the fifth annual fair of the Mobile agricultural, horticultural, and mechanical fair assn. 1878. Gulf Citizen 1:524-537.

The forests of Alabama, and their products. 1878. Pages 221-235 *in* Saffold Berney, ed. Hand book of Alabama. Mobile Register Press, Mobile, Ala. 338 pp.

The grasses, and other forage plants of Alabama: indigenous, naturalized, and cultivated. 1878. Pages 236-247 *in* Saffold Berney, ed. Hand book of Alabama. Mobile Register Press, Mobile, Ala. 338 pp.

Preliminary list of the plants growing without cultivation in Alabama, from the collections made by Eugene A. Smith, Tuscaloosa, and Chas. Mohr, Mobile, Ala. 1880. No publisher. 56 pp.

Analysis of *Eriodictyon californicum*. 1880. Proc. Amer. Pharm. Assoc. 27:736-740.

Rhus cotinoides, Nutt. 1882. Proc. Acad. Nat. Sci. Philadelphia, 1882:217-220.

On the distribution of the more important forest trees in the Gulf region. 1882. Amer. J. Forest. 1:78-88, 120-126.

On the distribution of the more important forest trees in the Gulf region. 1883. Amer. J. Forest. 1:179-184, 200-216.

Aboriginal soapstone quarry and shell-heaps in Alabama. 1883. Annual Rep. Smithsonian Inst., 1881:617-619.

List of trees and plants characteristic of each region of the state. 1883. Rep. Alabama Geol. Surv., 1881-82:291-297.

The natural resources of Alabama, displayed in the exhibit of the Louisville and Nashville Railroad Company, at the Southern Exposition, Louisville, Kentucky. 1883. Daily Register Press, Mobile, Ala. 22 pp.

On *Quercus durandii*, Buckley. 1883. Proc. Acad. Nat. Sci. Philadelphia, 1883:37-38.

The lands of the Louisville and Nashville Railroad in Alabama, as homesteads for the settler. 1884. Roberts and Son, Birmingham, Ala. 16 pp.

*Rare and little known trees and shrubs of Alabama. 1884. Trans. Mississippi Valley Hort. Soc. 2:216-219.

*Ueber die verbreitung der terpentin liefernden pinusarten im suden der vereinigten

staaten und ueber die gewinnung und verarbeitung des terpentin. 1884. Pharm. Rundschau (Berlin & New York) 2:163-166, 187-190.

The forests in the vicinity of Mobile. 1885. Pages 48-53 *in* Sub Rosa [pseudonym for Paul Ravesies], ed. Scenes and settlers of Alabama. No publisher. 120 pp.

*Regions of forest growth [in Texas, Louisiana, Mississippi, Alabama, and Florida]. 1885. Pages 66-67 *in* C. V. Riley, ed. Fourth report of the United States Entomological Commission.

*Ueber drei vereinzelte burger des floren-gebietes der nordamerikanischen sudstaaten. 1887. Pharm. Rundschau (Berlin & New York) 5:8-11.

*Untersuchung der blatter von *Gleditschia triacanthos*, L. 1887. Pharm. Rundschau Berlin & New York) 5:250.

*Forests of the United States. 1887. Pap. New Orleans Acad. Sci. 1:19-39.

Winter in Mobile. 1888. Gard. & Forest 1:16.

The hardwood forests of the South. 1888. Gard. & Forest 1:34-35.

Spring in Mobile. 1888. Gard. & Forest 1:88.

The long-leaved pine. 1888. Gard. & Forest 1:261-262.

*Ueber die verbreitung der pflanzen durch thiere. 1888. Pharm. Rundschau (Berlin & New York) 6:177-181.

The pecan tree (*Hickoria pecan*). 1889. Gard. & Forest 2:569-570.

The la[te]st addition to the shrubs of eastern North America. 1889. Gard. & Forest 2:592.

The medicinal plants of Alabama: systematic list of the medicinal plants occurring within the limits of the state, with notes on their distribution and proper time of collecting the parts used. 1890. Mobile Register Press, Mobile, Ala. 17 pp.

Vegetation in southern Alabama. 1890. Gard. & Forest 3:140, 212.

Pinus glabra. 1890. Gard. & Forest 3:295.

The Florida spruce pine. 1890. Gard. & Forest 3:402-403.

**Hickoria olivaeformis*. 1890. Pharm. Rundschau (Berlin & New York) 8:56-59.

*Die medicinischen pflanzen von Alabama. 1890. Pharm. Rundschau (Berlin & New York) 8:240-243, 257-262.

*Vegetation of Louisiana and adjoining regions, and its products, in relation to pharmacy and allied industries. 1891. Pharm. Rundschau (Berlin & New York) 9:132-135.

The general features of the vegetation of Louisiana and adjoining region, and its products in relation to pharmacy and allied industries. 1892. Proc. Amer. Pharm. Assoc. 39:76-84.

Our remaining hard-wood resources. 1892. Engineering Mag. 4:378-385.

Variation in the leaves of *Clematis reticulata* and other notes. 1892. Bull. Torrey Bot. Club 19:308-309.

*Die gebirgsflora Alabama. 1892. Pharm. Rundschau (Berlin & New York) 10:253.

The mountain flora of Alabama. 1892. Gard. & Forest 5:507-508.

The distribution of some forest trees in the southern states. 1893. Gard. & Forest 6:372-373.

*Die walder des sudlichen Alabamas. 1894. Pharm. Rundschau (Berlin & New York) 12:211-213.

*Die walder der alluvial region des Mississippi in den staaten Louisiana, Mississippi und Arkansas. 1895. Pharm. Rundschau (Berlin & New York) 13:14-15.

*Die walder des sudlichen Alabamas. 1895. Pharm. Rundschau (Berlin & New York) 13:30-33.

*Ueber das vorkommen des balsams von *Liquidambar styraciflua* L. 1895. Pharm. Rundschau (Berlin & New York) 13:57-58.

The timber pines of the southern United States: with an introduction by B. E. Fernow, and a discussion of the structure of their wood by Filibert Roth. U.S.D.A. Div. Forest. Bull. 13. 160 pp.

Notes on some undescribed and little known plants of the Alabama flora. 1897. Bull. Torrey Bot. Club 24:19-28.

Report on the forests of Sand Mountain. 1898. The Forester 4:211-215.

Notes on some new and little known plants of the Alabama flora. 1899. Bull. Torrey Bot. Club 26:118-121.

Alvin Wentworth Chapman. 1899. Bot. Gaz. (Crawfordsville) 27:473-478.

Plant life of Alabama: an account of the distribution, modes of association, and adaptations of the flora of Alabama, together with a systematic catalogue of the plants growing in the state. 1901. Contr. U.S. Natl. Herb. 6:1-921.

Plant life of Alabama. 1901. Alabama Geol. Surv. Monogr. 5. 921 pp.

*Notes on the red cedar. 1901. U.S.D.A. Div. Forest. Bull. 31. 37 pp.

PLANT LIFE OF ALABAMA

Mohr's major scientific work was *Plant Life of Alabama*, published July 31, 1901—just two weeks after his death. This work was produced with the assistance of the Geological Survey of Alabama and its head, Eugene Allen Smith, and represents an elaboration of the "Preliminary List" from the collections of Mohr and Smith (Mohr 1880).

Letters exchanged between Mohr and Smith fail to indicate when the decision was made to begin work on a complete flora of Alabama. However, in 1882, after completion of his field work for the Census, Mohr (1882d) wanted "to be left quietly at home" until he had completed "our Alabama Flora." Four years later, Mohr (1886) mentioned working on the Flora, and by 1889 he was ready to add the lower plants to it (Mohr 1889).

Concentrated work on the project was not begun until 1891, when approval of funding was granted by the governor of Alabama (Mohr 1891). Under the terms agreed upon, Mohr received $50 per month as a retainer, with the total amounting to $5 per finished page (Mohr 1892b, 1896b). Mohr was able to devote most of his time to the Flora after his retirement from the pharmacy business in 1892, although commitments to the U.S.D.A. had to be met also. In 1896, Mohr asked for and was granted a temporary reprieve from his Department of Agriculture duties (Mohr 1896e).

Work on the Flora accelerated in 1896. In that year a botanist at Auburn, Alabama—P. H. Mell—published a bulletin describing the plants of Alabama (Mell 1896). In this work, Mell utilized data obtained from Mohr. The *Botanical Gazette* (Anonymous 1896a) accused Mell of undermining Mohr's work, stating that "we cannot believe that this extensive information was obtained from our good friend with the expressed intention of anticipating his own flora. In other words, Dr. Mohr must have granted a favor that has been abused." Although a later article (Anonymous 1896b) in that journal exonerated Mell from blame, a series of letters exchanged between Mohr and Smith indicate that suspicions of Mell's abuse were valid (Mohr 1896c; Smith 1896b). Mohr soon after decided to treat the entire Mell affair with "silent contempt" (Mohr 1896d).

Later in 1896, Mohr indicated additional pressure to complete and publish his work from such botanists as John K. Small and Thomas H. Kearney.

He stated (Mohr 1896f): "By the activity with which of late the younger northern botanists begin to explore these parts, they are apt to take the wind out of my sails on many points." For this reason he decided to quickly publish his "novelties" in the *Bulletin of the Torrey Botanical Club*. He was further dismayed by the publication of Britton and Brown's *Illustrated Flora*, as he felt that it embraced a large number of southern plants (Mohr 1896h).

Although Mohr relied heavily upon his own experience, knowledge, and herbarium in writing *Plant Life of Alabama*, many other experts and collections were consulted. An updated catalogue of the plants contained in the Geological Survey collection was used as a working model, and this catalogue was sent to N. L. Britton for revision to fit the Rochester rules of nomenclature (Mohr 1893a). Mrs. N. L. Britton was asked to examine the portions of the manuscript concerning the mosses (Mohr 1899b). Specimens of the genus *Aster* were sent to Prof. Burgess in New York, while the grasses and *Silphium* were shipped to Columbia University for verification (Mohr 1897a, b). Mohr conversed with C. H. Merriam on plant distributions within the state (Mohr 1894). The Engelmann Herbarium at St. Louis was consulted, as well as the herbarium and libraries at Cambridge, Massachusetts (Mohr, 1893b, 1895).

Mohr constantly incorporated information from the most recent publications, even those published while *Plant Life* was in press (Mohr 1901a). In a letter to Tracy, Mohr (1900b) listed his last-minute revisions and consultation of the type material at the National Herbarium, with all changes made at "no matter what sacrifice of time and trouble."

Plant Life of Alabama was originally planned to be one of the publications of the Geological Survey of Alabama, and Mohr was partially supported by Survey funds from 1892 on. However, it became apparent to Smith that publication by the Survey would be far too costly and might necessitate the elimination of large parts of the work. He suggested that a publication arrangement be made with the Smithsonian Institution or with the Department of Agriculture, and that an extra edition with an altered title page be printed as an Alabama state document (Smith 1896a, c). Such an agreement was reached to print the work as a *Contribution from the U. S. National Herbarium* (Mohr 1896g).

Publication by the U. S. National Herbarium, however, resulted in a great number of problems. In Smith's opinion, the cost of publication became exorbitant, and he expressed regret at having the work published in Washington (Smith 1900). Although Mohr was informed in July, 1897, that the Printing Office was ready for his manuscript, the work was not published until four years—as well as Mohr's life—had elapsed. Mohr (1900c) could rightfully claim "to have been among the first (if not *the first*) to treat the flora east of the Rockies in respect to its ecological relations," but delays in printing his work allowed others to assume this distinction.

In its final form, *Plant Life of Alabama* is an expanded checklist of all plants known to occur in the state. Each species or variety of plant, from slime mold to angiosperm, is listed with a bibliographic citation, important synonyms, distribution, occurrence in the state, type locality, and the location of representative specimens. A tabular summary of the plants follows the checklist, as well as a list of cultivated species.

Plant Life of Alabama was lauded as "the most complete and philosophical local flora ever published . . ." (Tracy 1901). It is more than a mere checklist of plants, because the first 137 pages are descriptive. These pages include accounts of the history of Alabama botany, physiographic features of the state, plant distributions and associations, the relation of the Alabama flora to other floras, and a discussion of introduced plants and their influences. The work thus includes sections covering most of Mohr's interests.

Plant Life of Alabama was planned to be the first of a two-volume work on the botanical resources of Alabama, with the second volume dedicated to the economic plants (Smith 1901a). While the economic volume was viewed as being more immediately valuable to the populace, it was felt that the systematic volume was needed first (Smith 1896a).

The earliest mention of an Economic Flora of Alabama was made in 1887, while the first remittance for such work was forwarded in 1899 (Mohr 1887; Smith 1899). The first 350 pages of the work were to be devoted to trees and shrubs, with a sketch of forest botany, while short descriptions of plant families would be included to allow the work to be used as a systematic botany textbook (Mohr 1901b, c).

It is generally believed that Mohr's work on an Economic Flora was progressing well at the time of his death, although a search of Mohr's belongings by his son, Herman B. Mohr, failed to locate the manuscript. His son later implied that, due to his father's failing mental faculties, actual work on the Economic Flora may never have begun (H. B. Mohr 1901a, b). If a manuscript was produced, it is possible that Harper used it as a basis for his very similar work (Harper 1928). However, an examination of the extensive Harper material at The University of Alabama, Gorgas Library, Special Collections failed to turn up Mohr's manuscript.

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TAXONOMY AND DISTRIBUTION OF *GENTIANA* (GENTIANACEAE) IN MEXICO AND CENTRAL AMERICA. II. SECT. *CHONDROPHYLLAE*[1]

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This paper is the second of two monographs on *Gentiana* L. in Mexico and Central America. Delineation of the genus, terms pertaining to its morphology, and other introductory topics were discussed in the first paper (Pringle 1977), which also included a key to the sections of *Gentiana* in these regions.

GENTIANA [sect.] CHONDROPHYLLAE Bunge, Nouv. Mém. Soc. Imp. Naturalistes Moscou 1:207. 1829. Lectotype species (Pringle 1978): *Gentiana aquatica* L.

Varasia Philippi, Florula Atacamensis p. 35. 1860. Type species (only species cited): *Gentiana podocarpa* (Philippi) Griseb., as *Varasia podocarpa* Philippi.

Chondrophylla (Bunge) A. Nels., Bull. Torrey Bot. Club 31:245. 1904 (pro gen.).

Holubia Löve & Löve, Anales Inst. Bot. Cavanilles 32:226. 1975. Type species: *Gentiana pyrenaica* L., as *Holubia pyrenaica* (L.) Löve & Löve. Non *Holubia* Oliver, Hooker's Icon. Pl. 15:59. 1884.

Holubogentia Löve & Löve, Bot. Not. 131:385. 1978. Based on *Holubia* Löve & Löve, non Oliver.

Plants monocarpic or perennial. Roots slender, branched; taproot persistent in annual species. Stems solitary or clustered, usually branched except in minute plants, decumbent to erect, slender, in many species less than 15 cm long, up to 30 cm in others. Basal and lower cauline leaves of most monocarpic and some perennial species persistent, crowded, and broader than median and upper cauline leaves. Leaf bases strongly connate-sheathing. Blades usually less than 1.5 cm long, scalelike to oblanceolate, oblong, or orbicular, usually carinate. Margins obscurely to prominently white-cartilaginous, entire or minutely denticulate. Flowers solitary or in small, condensed cymes, without involucral bracts, 5–30 mm long. Calyx tubes 5– or 15–veined, cylindric to funnelform, uncleft. Calyx lobes deltoid to oblong, often carinate, with cartilaginous margins. Intracalycular membrane discontinuous or not developed. Corollas usually pale to deep blue, sometimes white, pale yellow, or violet, usually suffused externally with green and/or deep violet, often

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SIDA 8(1): 14–33. 1979.

photo-, thigmo-, and seismonastically closing. Corolla tubes cylindric to funnelform. Corolla lobes abruptly wide-spreading, shorter than tube, deltoid to ovate or oblong-ovate. Free portions of corolla appendages nearly symmetrical, uncleft to shallowly or deeply bifid, or erose to fimbriate. Stamens equal, with straight filaments. Anthers free or loosely connate. Pollen grains oblate-spheroidal to prolate. Sexine striate, striato-reticulate, or nearly smooth. Ovaries compressed-ellipsoid, usually widest near middle, abruptly contracted at summit. Stigmas short, in most species sessile or subsessile, in some elevated by a well-developed style. Gynophores of some species greatly elongating in fruit, remaining short in others. Carpels each with 1 dorsal and 2 ventral veins. Ovules in 4 parietal zones corresponding to positions of ventral carpel veins. Seens ovoid to ellipsoid, often apiculate, wingless or with narrow, incomplete wings. Testa striato-reticulate. Sectional description compiled from Kusnezow (1895), Lindsey (1940), Nilsson (1967), Toyokuni (1963), and my own observations.

Section *Chondrophyllae* occurs in the Pyrenees, the Alps, and the Carpathians; in the Caucasus, the Himalayas, Siberia, China, Japan, and Southeast Asia; in Indonesia, New Guinea, and the Philippines; from the Aleutians and the Brooks Range in Alaska through the Rocky Mountains to Arizona; in Mexico, Guatemala, and Costa Rica; and in the Andes from Venezuela to Tierra del Fuego. Throughout its range, this section is confined largely to mountainous regions, with many of its species occurring above treeline.

The pollination of *G. prostrata* Haenke in Europe has been discussed by Kerner von Marilaun (1891), who concluded that although outcrossing was promoted by protandry, autogamy could readily occur within corollas prevented from opening by prolonged cloudy periods. Similarities in corolla morphology and in pistil and anther development indicate that these conclusions are generally applicable to the species discussed in the present paper. The widespread phenomenon of thigmonastic corolla-closing in this section is usually assumed to be related to pollination, but its specific role has not been investigated.

From the field aspect of open capsules of *G. perpusilla* Brandegee, it appears that the fruits of this and some other species of sect. *Chondrophyllae* function as splash-cups. In species with more elongate gynophores, seeds are probably dispersed as wind shakes the fruits (censer mechanism). Many species grow where rill action can further disperse the seeds after they have fallen. Long-distance dispersal evidently has also occurred, since the alpine habitats of the Mexican and Central American species are widely separated, are mostly of late Tertiary or Quaternary origin, and have no history of connection by continuous alpine vegetation.

Since its establishment by Bunge, sect. *Chondrophyllae* has been accepted as a section of *Gentiana* by most authors, except for those who restricted *Gentiana* to the five species usually treated as its nominate section. *Varasia* Philippi and *Chondrophylla* (Bunge) A. Nels. were equivalent to sect.

Chondrophyllae only. Neither of these names has been used recently.

Löve & Löve (1975) divided sect. *Chondrophyllae* between two segregate genera. The "annual or biennial species with $x = 9$" were placed, along with sect. *Ciminalis* (Adans.) Dumort. (which consists of perennial species), in the genus *Ciminalis* Adans. emend. Holub (type species: *Gentiana acaulis* L., in sect. *Ciminalis*, as *Ciminalis* [sp.]). The "perennial species . . . with . . . $x = 13$," believed by Löve & Löve to comprise "about ten species of Eurasia, North and South America," formed *Holubia* Löve & Löve, later renamed *Holubogentia* Löve & Löve. Weaver & Rüdenberg (1975), however, reported $n = 20$ in plants called *G. sedifolia*, but probably an unnamed, closely related species, in Venezuela. In Löve & Löve's generic concept, this species, perhaps with certain Asiatic species having $n = 10$, will presumably be treated as a third genus.

Little can now be postulated about relationships within sect. *Chondrophyllae* in the Western Hemisphere, because its diversity has largely remained unrecognized. Existing information on chromosome numbers and pollen morphology indicates that phylogenetic studies will require more such data. Subdivisions of sect. *Chondrophyllae* are therefore not considered here.

In this study, I examined specimens in the following herbaria: BM, DS, ENCB, F, GH, HAM, K, MEXU, MICH, MO, MSC, NY, TENN, US, and WIS (abbreviations from Holmgren & Keuken 1974). Among these are collections each comprising several to many plants, representing well the variation that may occur within a population. Specimens from South America, northern North America, and Eurasia were among those studied, and *G. perpusilla* and *G. prostrata* were observed in the field. Consequently, it has been possible to compare the Mexican and Central American plants with those in other regions, and to distinguish, with reasonable confidence, taxonomically significant differences among populations from minor variations among individuals.

All of the species discussed here have sometimes been equated with *G. prostrata*. Comparisons with specimens of *G. prostrata* from Colorado (Figs. 7, 13), Alaska (Fig. 19), and the type region in Austria, however, indicate that all of the Mexican and Central American plants are distinct from this species. *Gentiana fieldiana*, which resembles *G. prostrata* in its leaf shape and in its apiculate corolla lobes, differs in its wider white leaf margins, in the more oblong shape and strict apical symmetry of its corolla lobes, in the greater adnation of its stamens, and in its usually cymose inflorescences. *Gentiana sedifolia* resembles *G. prostrata* in its narrow leaf margins and in the long free portions of its filaments, but differs in its proportionately much narrower leaves, in its blunt corolla lobes, in its more copiously and more irregularly erose-serrate corolla appendages, and in its coarser sexine sculpturing without well-developed longitudinal striations. The other species differ even more sharply from *G. prostrata*: *G. beamanii* in its narrower leaves and in the much shorter free portions of its stamens, *G. perpusilla*

in its proportionately small corolla lobes and in its uncleft, nearly entire corolla appendages, and *G. pumilio* in its proportionately much broader leaves, in its wide and prominently denticulate leaf margins, and in its spheroidal pollen grains.

KEY TO MEXICAN AND CENTRAL AMERICAN SPECIES

1a. Leaves imbricately crowded, broadly spatulate to orbicular, many with 5 or more prominent primary veins and 2–4 lesser ones; white leaf margins conspicuous, ca. 0.3 mm wide, those of upper leaves denticulate from below middle to apex; flowers often sessile in small clusters; calyx tube largely concealed by leaves; pollen grains spheroidal ..... 4. *G. pumilio*

1b. Leaves, except sometimes near base of stem, less densely crowded and proportionately narrower, usually with only 1 or 3 prominent primary veins; white leaf margins 0.2 mm or less in width, entire or denticulate above middle; flowers solitary at end of main stems and branches; calyx tube not concealed; pollen grains subprolate to prolate.

2a. Leaves linear-oblong, usually more than 3 times as long as wide, slightly to strongly divergent from near base; stamens becoming free in lower 2/5 of corolla, with free portions, including anthers, 3–7 mm long; throat of corolla with distinct color demarcation ..... 1. *G. sedifolia*

2b. Leaves oblanceolate to obovate, usually less than 3 times as long as broad, if proportionately longer then proximally appressed-ascending, only the distal portion spreading; stamens becoming free near or above middle or corolla, with free portions up to 3 mm long, or, if diverging lower, then with free portions up to 2 mm long and with corolla appendages subentire; throat of corolla with or without color differentiation.

3a. Stems erect except at base, with strongly ascending branches; internodes, except near base of stem, mostly as long as or longer than subtending leaves; leaf blades mostly over 5 mm long; throat of corolla with distinct markings ..... 2. G. *beamanii*

3b. Stem and branches variously spreading; internodes mostly much shorter than subtending leaves; many leaf blades less than 5 mm long; corolla throat paler but neither sharply demarcated nor streaked.

4a. White leaf margins and keel well defined, those of upper leaves distinctly denticulate; corolla lobes oblong-triangular, abruptly rounded to apiculate tip; free portions of corolla appendages erose-serrate; stamens becoming free near middle of corolla ..... 3. *G. fieldiana*

4b. White leaf margins and keel obscure, generally entire or shallowly undulate; corolla lobes ovate-triangular, tapering gradually to subacute tip; free portions of corolla appendages entire or nearly so; stamens becoming free below middle of corolla ..... 5. *G. perpusilla*

TAXONOMIC TREATMENT

1. GENTIANA SEDIFOLIA H.B.K., Nov. Gen. Sp. Pl. 3:173. 1819 (quarto text). Type: without locality [probably ECUADOR: Napo or Pichincha]: *Humboldt & Bonpland s.n.*, no date [probably Jan-Jun 1802] (holotype P, photo MSC! isotype K!). Figs. 1, 8, 14.

Gentiana cespitosa Willd. ex Schultes, Syst. Veg. 6:185. 1820. Type: Duplicate *Humboldt et al.*, cited above (B-herb. Willd.). (Ex char. and fide Kunth in

Humboldt et al., 1823.)

Gentiana chimboracensis Willd. ex Schultes, Syst. Veg. 6:185. 1820. Type: ECUADOR: Chimborazo: Chimborazo, *Humboldt et al. s.n.*, no date (B-herb. Willd.). (Ex char.)

Ericala sedifolia (H.B.K.) G. Don, Gen. Hist. 4:189. "1838" [1837].

Gentiana edifolia var. *casapaltensis* J. Ball, J. Linn. Soc., Bot. 22:49. 1885. Type: PERU: Lima: supra Casapalta [Casapalca], *Ball s.n.*, 22 Apr 1882 (holotype K! isotype GH!).

Gentiana sedifolia var. β *grandiflora* Kusn., Trudy S.-Peterburgsk. Obshch. Estestvoisp., Otd. Bot. 24(2):217. 1894. Syntypes: ECUADOR: Napo or Pichincha: Antisana, *Lehmann*, no. and date not cited (LE) and COLOMBIA: Magdalena: Santa Marta, *Lehmann*, no. and date not cited (LE); probable isosyntype, "Cordillera of Ecuador and Colombia," *Lehmann 623*, 22 Dec 1880 (K!).

Plants usually 1.3–4 cm tall, occasionally up to 6 cm. Stems 1-many. Well-developed stems decumbent at least at base and often for much of length; longer stems usually much branched. Leaves linear-oblong, 5–10 mm long, 1.5–2.5(-3) mm wide, apiculate. White leaf margins inconspicuous and sometimes not sharply defined, mostly 0.02–0.06 mm wide distally on lower leaves, ca. 0.1 mm wide on upper leaves, entire or irregularly and minutely denticulate toward apex. Basal leaves persistent, crowded, less conduplicate than cauline leaves. Cauline leaves increasingly conduplicate and sometimes more or less arcuate on upper part of stem (except on very small plants), with midrib keels more distinctly developed (white portions up to 0.05 mm wide). Median and upper internodes often scarcely longer than sheathing leaf bases, sometimes up to 2–6 mm long. Calyx tube 5.5–8 mm long, ridged distally along median sepal veins. Calyx lobes ovate-triangular, erect proximally, sometimes more or less arcuate distally, conduplicate and narrowly carinate toward apex, (1.2–)1.8–4 mm long, acute, with white margins ca. 0.2 mm wide, widening near apex, and keel up to 0.05 mm wide; margins and keel entire. Corollas 9–20 mm long when closed; expanded limb 6–14 mm across. Corolla tube 6.5–17 mm long. Lobes broadly ovate-triangular, 1.8–4 mm long, as wide or slightly wider than long, obtuse to subacute. Free portions of appendages ca. 0.75 times as long and about as wide as lobes, broadly rounded to triangular, shallowly to rather deeply erose-serrate or shallowly several-cleft near apex, not distinctly bifid. Corolla tube yellowish-white; upper portion suffused with deeper yellow and often bordered and spotted with purplish-brown. Uppermost part of fused portion of corolla, lobes, and free portion of appendages pale to deep blue, with a narrow whitish zone next to yellowish eye, or occasionally yellowish-white throughout; exterior surface of lobes, except near inner margin, and adjacent portions of tube suffused with deep violet (scarcely or not at all in white-flowered forms) and also with green, especially near tips of lobes. Stamens becoming free at 1/4–2/5 total height of corolla; free portions (including anthers) 3–7 mm long. Pollen grains prolate. Sexine relatively coarsely striato-reticulate. Pistil tapering into style ca. 1 mm long. Capsule 3–5 mm

Figs. 1–3. Herbarium specimens of *Gentiana* spp. Fig. 1. *G. sedifolia* (*Mulroy 1099*, HAM, from Ecuador). Fig. 2. *G. beamanii* (*Beaman 3899*, MSC). Fig. 3. *G. fieldiana* (*Beaman 3071*, MSC, a relatively large plant).

long, elevated well above marcescent corolla by gynophore 15–18 mm long at maturity. Seeds ellipsoid, light brown, striato-reticulate, ca. 0.85 mm long, 0.4 mm in diameter.

Central American specimens examined:

COSTA RICA: Cartago (all from Cordillera de Talamanca, near Cerro de la Muerte): not more specifically located, *Carlson 3630* (F); Ciénega "3 de Junio," at km 73 SE of San José on Carretera Panamericana, *Jiménez M. 1993* (F, NY), *Jiménez M. 3372* (F), *Lent 405* (NY), and *Anderson & Mori* 231 (BM, DS, F, WIS); near Ojo de Agua, *Williams et al. 28281* (BM, F, WIS); La Trinidad, between km 60 and 77, *Molina R. et al. 17855* (F, GH). Border of Cartago and San José: Cerro de la Muerte, *Heithaus 318* (MO). San José: Cerro de Buena Vista, *Tonduz (Pittier exped.) 3498* (US); Cerro de las Vueltas, *Standley & Valerio 43640* (F, US). PANAMA: Chiriquí: between Cerro Bine and Itamut, *Weston 10175* (MO; first report of *Gentiana* in Panama).

In Central America, *G. sedifolia* is known only from high elevations in the Cordillera de Talamanca in Costa Rica and the adjacent Cordillera Central in Panama (Fig. 20). It is widely distributed in the Andes of South America, from Colombia and Ecuador south at least to the Cordillera Central of southern Peru (Fig. 21).

Herbarium data indicate that *G. sedifolia* in Costa Rica and Panama grows in boggy depressions and similar wet sites in meadows from 2275 to 3335 m elevation. Plants have been collected in flower from December through July.

In their original description of *G. sedifolia*, Humboldt et al. (1819) reported having seen this species "in montibus ignivomis Antisanae [Ecuador], Puracé, Páramo de Almaguer [Colombia], etc., alt. 1600–1800 hex. [= 3072–3456 m]." On the basis of minor geographic variations in this species, discussed below, it seems most likely that the type was collected on or near Antisana.

Distinctive vegetative features of *G. sedifolia* throughout its range include the proportionately long-tapering leaves and the very narrow white margins. Distinctive floral features include the funnelform corolla tube, which widens more conspicuously from base to summit than the nearly cylindric corolla tubes of the other species described here, and the relatively low divergence and long free portions of the filaments. Pollen grains of *G. sedifolia* from Costa Rica closely resemble those of Ecuadorean specimens, the sexine in both being relatively coarsely reticulate, with poorly developed longitudinal striations.

The two later species names cited above have generally been accepted as synonyms of *G. sedifolia*, at least the first having been based on the same collection (Humboldt et al., 1823). Ten taxa, with 11 epithets, were described as varieties, subvarieties, or forms of *G. sedifolia* during the 19th Century, but, except for the two cited above, their names seem to have been based on specimens of other species. Because all of these names were based on South American plants, a thorough investigation of their status has not

been included in this study. More recent collections, however, have indicated that much of the variation in *G. sedifolia* occurs within populations. Conspicuous variation exists in stem and internode length, but extremes can be found within a single population and even within a single collection, e.g., *Couthouy in 1855* (GH), from Ecuador, and *Pennell & Hazen 9996* (GH), from Colombia; some variation may occur among the stems of an individual plant. This variation, appearing to represent responses to seasonal factors and differences in microhabitat, is not recognized taxonomically here. Maximum flower size is greater in Ecuador than farther north, but there is considerable variation in all regions and no discontinuities are evident. Corolla color likewise varies within populations.

Plants of *G. sedifolia* from the region of Antisana and Cotopaxi in Ecuador often have relatively long, much-branched prostrate stem bases, which appear brownish-black from the remains of old leaf bases, and from which adventitious roots arise. Such plants resemble the type collection and appear to be long-lived and probably recurrently flowering, corresponding to the description of *G. sedifolia* as perennial by Humboldt et al. (1819). Plants from other parts of the range of *G. sedifolia* generally have less well developed prostrate stems, without blackish leaf remnants, and root systems comprising only the primary root and its branches. These plants appear to be relatively short-lived and monocarpic. Longevity and life cycles are, however, difficult to determine in specimens from the tropics, and no year-round observations have been made on populations of this species. Therefore it is not certain whether these differences represent genetic differentiation, or whether climatic conditions near the Equator permit greater longevity of individual plants. Weberbauer (in Gilg, 1906), however, commented on the inadequacy of plant size and apparent longevity as bases for dividing *G. sedifolia*, noting that at a single locality in Peru plants of this species might exhibit all stages of intergradation from minute, unbranched, one-flowered forms with a single filiform root to large, much-branched, patch-forming plants. Therefore no variants based on apparent longevity are recognized here.

2. GENTIANA **beamanii** Pringle, sp. nov. Figs. 2, 9, 15.

Caules plus minusve erecti, 3.5–16 cm alti, internodis vulgo longioribus quam foliis. Folia oblanceolata vel anguste spathulata, 5–10 mm longa, 1.5–2 mm lata, proximale fere ascendentia et distale patentia, marginibus albis usque ad 0.05 mm latis, apicem versus minute denticulatis. Tubus calycis 5–8 mm longus. Lobi calycis triangulares, 1.8–3 mm longi, acuti, marginibus albis circa 0.15 mm latis. Tubus corollae cylindricus, 8.5–14 mm longus. Lobi corollae late ovato-triangulares 1.5–3 mm longi, subacuti, indici. Partes librae plicarum triangulares, eroso-serratae et emarginatae, breviores quam lobi. Filamenta staminum sese liberantia aliquantum supra medium corollae totae, partibus libris antheribus inclusis circa 2.5 mm longis. Pollinis grana subprolata vel prolata, sexinio striato-reticulato. Capsula 4–6 mm longa, in parte exserta.

Type: GUATEMALA: Huehuetenango: Sierra de los Cuchumatanes, immediately N of Tojiah [Tojquiá] at km 322 on Ruta Nacional 9N, *Beaman 3899*, 1 Aug 1960 (holotype MSC, isotypes GH, US). Paratypes: GUATEMALA: Huehuetenango:

vicinity of Chémal [Xémal], Sierra de los Cuchumatanes, *Steyermark 50287*, 8 Aug 1942 (F, GH).

Plants 3.5–16 cm tall. Stems more or less erect throughout or basally decumbent, usually 1–6, each usually with 1–3 branches arising in basal half and reaching about equal height, sometimes with additional branches from upper axils. Leaves usually broader and more closely spaced near stem base; lowest leaves (sometimes shriveled at flowering time) elliptic-oblong or oblanceolate, 5–15 mm long, 1.8–4 mm wide, spreading or ascending, scarcely conduplicate. Median and upper cauline leaves oblanceolate to narrowly spatulate, 5–10 mm long, 1.5–2 mm wide, increasingly conduplicate upward; proximal portions (ca. 1/3 near middle of stem, ca. 2/3 near summit) appressed-ascending, distal portions more or less arcuate-spreading. Leaf apices abruptly acuminate, apiculate. White leaf margins almost obsolete proximally, widening distally to ca. 0.08 mm, entire or sparsely and minutely undulate-denticulate above middle. Midrib keel of similar width, minutely denticulate above middle. Internodes distinct, all but lowest few usually 1–2.5 times as long as subtending leaves. Calyx tube 5–8 mm long, slightly ridged along midveins. Calyx lobes triangular, 1.8–3 mm long, acute to acuminate, scarcely to moderately conduplicate, erect or slightly arcuate-spreading distally, with white margins ca. 0.15 mm wide, entire or nearly so, and keel up to ca. 0.08 mm wide, entire or sparingly denticulate. Corollas 10–17 mm long when closed; expanded limb 6.5–12 mm across. Corolla tube 8.5–14 mm long. Lobes broadly ovate-triangular, 1.5–3 mm long, slightly wider than long, subacute to acute. Free portions of appendages ca. 0.8 times as long and about as wide as lobes, triangular, sparingly erose-serrate, usually emarginate to shallowly bifid. Corolla tube mostly whitish, blue above, with dark purple streaks on interior surface of throat, in 2 lines in each petal proper and 1 in each appendage; lobes and free portions of appendages medium blue; exterior surface with deep violet pigment between relatively pale margin and overlapping edge (when closed) of next lobe, giving striped appearance. Filaments becoming free slightly above 1/2 total height of corolla; free portions (including anthers) ca. 2.5 mm long. Pollen grains subprolate to prolate. Sexine relatively finely striato-reticulate. Pistil tapering into style ca. 1 mm long. Capsule 4–6 mm long, about 2/3 exserted from marcescent corolla by gynophore 7–10 mm long at maturity. Seeds not seen.

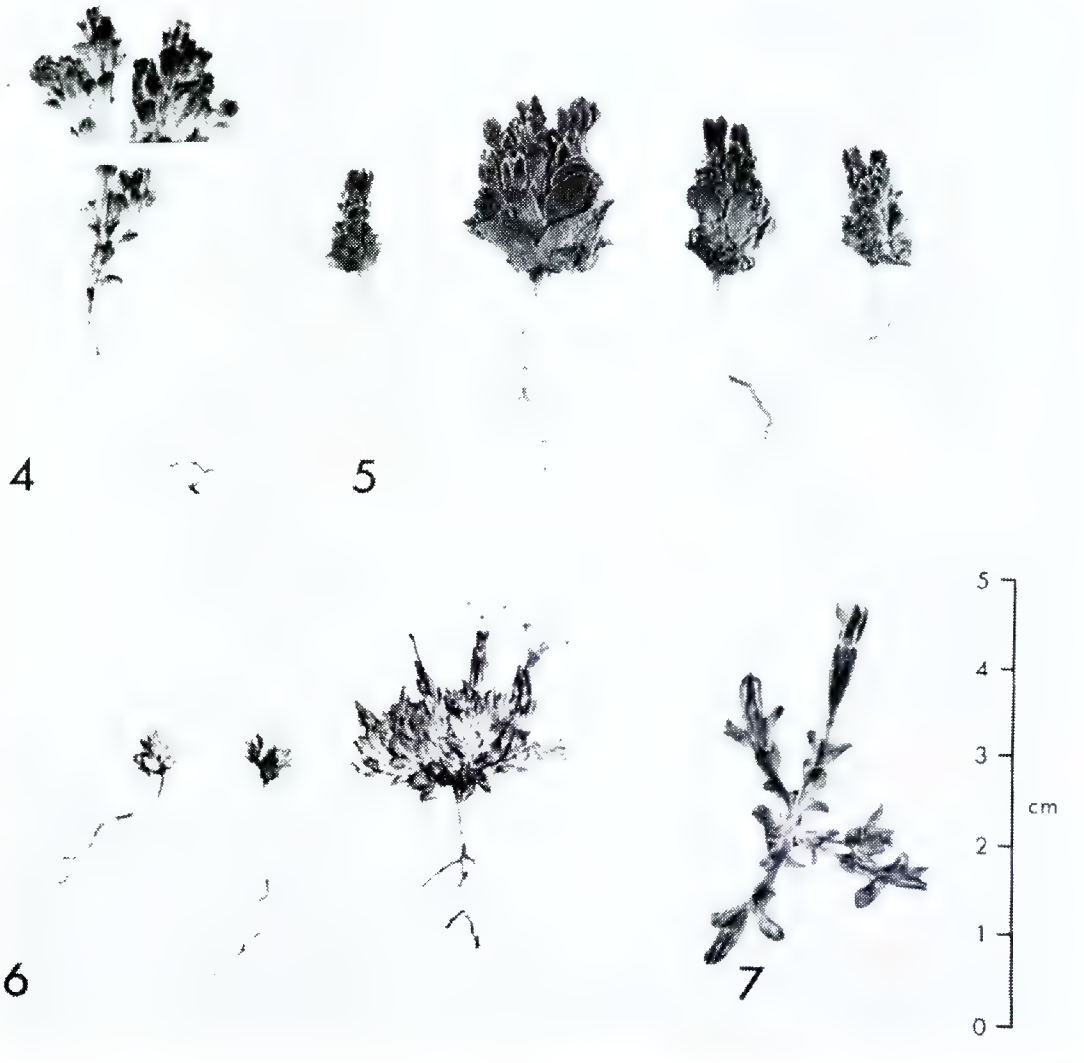
Gentiana beamanii is known only from a small area in Los Altos Cuchumatanes, Guatemala (Fig. 23). Both collections cited were made along small streams in meadows at altitudes of 3200-3750 m.

This species is named for Dr. John H. Beaman, author of several papers on the alpine flora of Mexico and Guatemala, whose notes and comments on differences among the Central American species of sect. *Chondrophyllae* have been very helpful in this study.

The elongate, erect stems and widely separated leaves of *G. beamanii* give this species an aspect unique among Central American species of sect.

Chondrophyllae. Its distinctness from plants treated here as *G. fieldiana* was first noted by Steyermark (in sched., *Steyermark 50287*), as follows: "Corolla larger, broader, and with longer tube . . . corolla-lobes with deeper purple in outer lobes [sic] . . . also stems with more branching and with more flowers than in other smaller type." Beaman (unpublished notes) likewise contrasted these plants, noting that those here called *G. beamanii* had narrower leaves with less conspicuous white margins.

Of the three Guatemalan species, *G. beamanii* is the closest to *G. sedifolia* in floral morphology. It differs conspicuously, however, in its cylindric, abruptly flaring corolla tube and in the much greater adnation of its stamens.



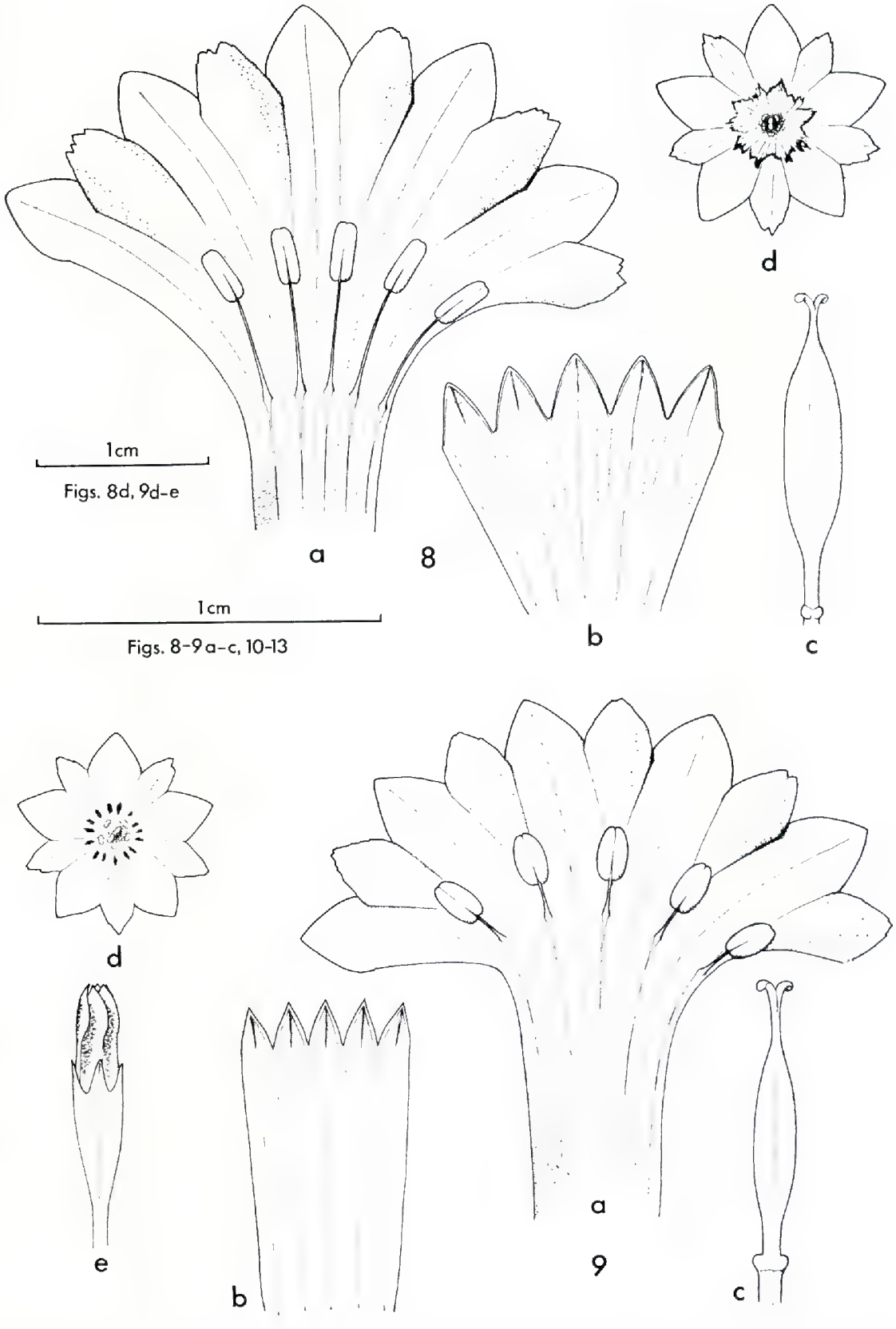
Figs. 4–7. Herbarium specimens of *Gentiana* spp. Fig. 4. *G. fieldiana* (*Beaman 3071*, MSC, a plant ca. average size). Fig. 5. *G. pumilio* (*Matuda 2868*, HAM) Fig. 6. *G. perpusilla* (*Pringle 1749*, HAM). Fig. 7. *G. prostrata* (*Shacklette 6013*, MICH, from Colorado). Figs. 1–7 to same scale.

3. GENTIANA **fieldiana** Pringle, sp. nov. Figs. 3, 4, 10, 16.

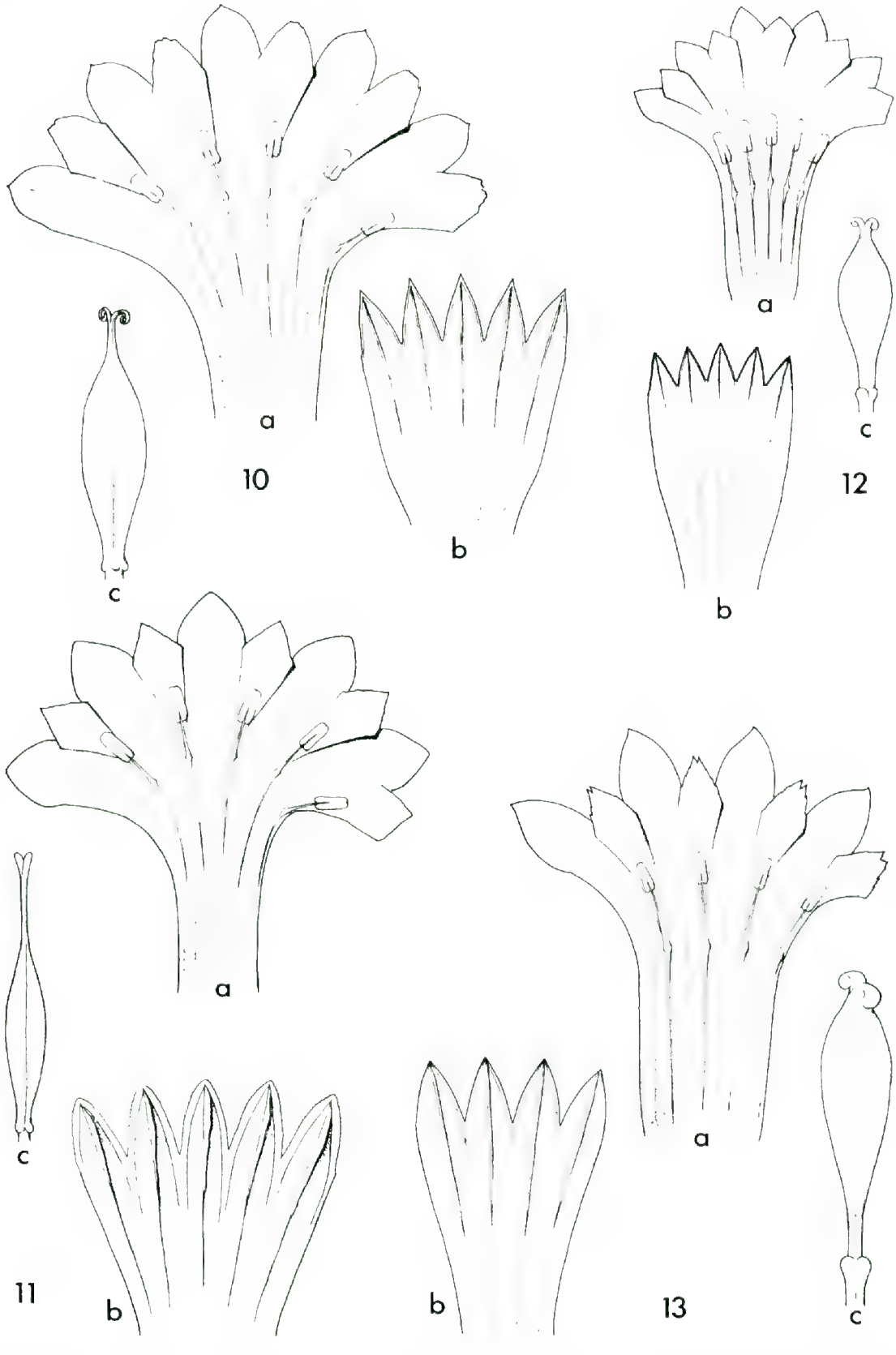
Caules ascendentes vel erecti, 1–4(–6.5) cm alti, vulgo pauciramosi. Folia congesta. Folia basalia oblongo-oblanceolata vel elliptico-obovata, 4–9 mm longa et 2–4 mm lata. Folia supera angustiora, marginibus albis carinisque circa 0.05 mm latis, apicem versus minute denticulatis. Tubus calycis 5–8 mm longus. Lobi calycis triangulares, acuminati, marginibus albis circa 0.05 mm latis, integris. Tubus corollae cylindricus, 4.5–10 mm longus. Lobi corollae oblongo-triangulares, 1.5–2 mm longi, apiculata, azurei aut albi. Partes librae plicarum triangulares, eroso-serratae et vulgo emarginatae, breviores quam lobi. Filamenta staminum sese liberantia circa medium corollae totae, partibus libris antheribus inclusis circa 2 mm longis. Pollinis grana prolata, sexinio striato-reticulato. Capsula 3–5 mm longa, in parte vel in toto exserta.

Type: GUATEMALA: Huehuetenango: Chémal [Xémal], at km 318 on Ruta Nacional 9N, *Beaman 3071*, 4 Aug 1959 (holotype MSC). Paratypes: GUATEMALA; Huehuetenango (all from Los Altos Cuchumatanes): vicinity of Tunimá [Tuinimá], *Steyermark 48368*, 7 Jul 1942 (F, GH); 2.5 mi E of San Mateo Ixtatán, *Steyermark 49875*, 31 Jul 1942 (F); near Páquix, *Sharp 451025*, 24 Dec 1945 (F, TENN); E of Tocquin [Tojquiá], *Holdridge 2345*, 27 Apr 1948 (US); Llano de Tierra Blanca, near trail to Todos Santos from Llano de San Miguel, near Chémal [Xémal], ca. 5 km W of km 311 on Ruta Nacional 9N, *Beaman 3118*, 5 Aug 1959 (MSC); 3 km S of road betwetn Llano de San Miguel and Todos Santos, from a point 2.5 mi W of Llano de San Miguel, *Beaman 3975*, 2 Aug 1960 (MSC); 7 mi N of Santa Eulalia along road to San Mateo Ixtatán, *Breedlove 8596*, 5 Feb 1965 (F); along road to San Pedro Soloma, 3 mi SW of San Mateo Ixtatán, *Breedlove 8637*, 6 Sep 1965 (F, US). Totonicapán: near Cumbre del Aire, on road between Huehuetenango and Siga, *Standley 65939*, 20 Feb 1939 (F); Tecum Umán Ridge at km 154 on Ruta Nacional No. 1, ca. 20 km of Totonicapán, *Beaman 4205*, 14 Aug 1960 (MSC).

Plants 1–4(–6.5) cm tall. Stems 1–12, ascending to erect, those of larger plants usually with 1–4 branches at various levels and further branched near summit, bearing flowers in small, leafy cymes. Basal leaves (sometimes more or less marcescent at flowering time) spreading, scarcely conduplicate, with midrib keel well developed only near apex, broadly oblong-oblanceolate to elliptic-obovate, usually 4–9 mm long, 2–4 mm wide. Cauline leaves somewhat narrower, increasingly conduplicate and carinate upward; upper ones carinate for most of length. Leaf apices acute, apiculate. White leaf margins and keel sharply defined, both 0.05–0.13(-0.2) mm wide, or slightly wider toward apex, at least upper leaves with keel and usually margins minutely denticulate. Leaves of most plants densely crowded throughout; those of taller plants often more distant on lower part of stem, with lower internodes up to twice as long as subtending leaves, but crowded on upper part. Calyx tube 5–8 mm long. Calyx lobes triangular, 1–1.5 mm long, erect, scarcely conduplicate, acute to acuminate, with white margins ca. 0.05 mm wide, entire, and keels scarcely developed or up to 0.04 mm wide. Corollas 6–12 mm long when closed; expanded limb 5–8 mm across. Corolla tube 4.5–10 mm long. Lobes oblong-triangular, 1.5–2 mm long, apiculate. Free portions of appendages ca. 0.75 times as long and about as wide as lobes, triangular, erose-serrate, sometimes emarginate. Corolla tube mostly whitish; lobes, free



Figs. 8–9. *Gentiana* spp. Fig. 8. *G. sedifolia.* Fig. 9. *G. beamanii.* a, interior surface of corolla, slit longitudinally and pressed; b, exterior surface of calyx; c, pistil; d, intact open flower from above; e, closed flower.



Figs. 10–13. *Gentiana* spp. Fig. 10. *G. fieldiana*. Fig. 11. *G. pumilio*. Fig. 12. *G. perpusilla*. Fig. 13. *G. prostrata* (drawn from a specimen from Colorado, where this species normally bears tetramerous flowers). a, interior surface of corolla, slit longitudinally and pressed; b, exterior surface of calyx; c, pistil.

portions of appendages, and uppermost portion of tube white to medium blue; exterior surface of lobes, except near margins, suffused with green, and occasionally also with deep violet-blue except near inner margin. Stamens becoming free at ca. 1/2 total length of corolla; free portions (including anthers) ca. 2 mm long. Pollen grains prolate. Sexine relatively coarsely striato-reticulate. Pistil tapering into style ca. 1 mm long. Capsule 3–5 mm long, 2/3 to entire length and up to 2 mm of gynophore exserted from marcescent corolla at maturity. Seeds ellipsoid, light brown, striato-reticulate, ca. 0.7 mm long, 0.35 mm in diameter.

Gentiana fieldiana is native to the Sierra Madre and Los Altos Cuchumatanes in Guatemala (Fig. 22) where it grows in moist sites in subalpine meadows (llanos) and openings in pine forests, from 2500 to 3500 m. Plants have been collected in flower from December through July. Its name honors the contributions of botanists now and formerly of the Field Museum of Natural History to the knowledge of the flora of Guatemala, especially Dr. Julian A. Steyermark and the late Mr. Paul C. Standley, who first collected this species.

A conspicuous feature of all but the smallest plants of *G. fieldiana* is the presence of 1-several short, leafy branches near the summit of the stem, with the flowers thus being borne in small cymes. In this trait, *G. fieldiana* differs from *G. sedifolia, G. beamanii,* and *G. prostrata,* in all of which solitary flowers generally terminate longer branches or unbranched stems (one such branch occasionally present in *G. sedifolia*). Also, *G. fieldiana* differs from the other species discussed here in that its corolla lobes taper abruptly to an apiculate tip, rather than gradually from near the base. Its pollen is similar to that of *G. sedifolia*, but the sexine pattern is more distinctly striato-reticulate, rather than simply reticulate, and the lirae are finer.

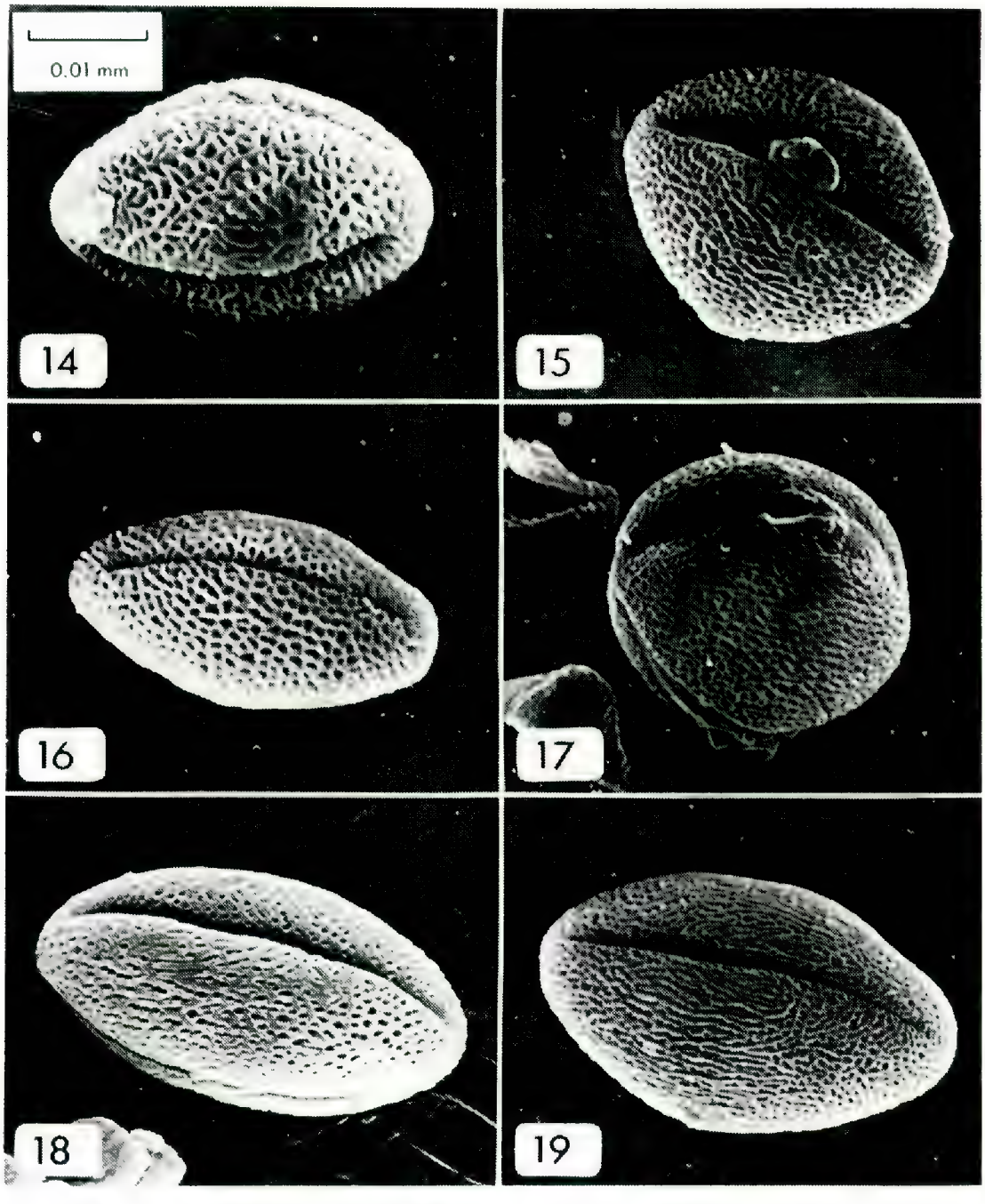
Photographs of living plants of *G. fieldiana* were not available for this study, but *Breedlove 8637* and *Sharp 451025* contain some corollas pressed while open, with the colors well retained. From these specimens it appears that no guidelines or sharply contrasting corolla-throat patterns are present in this species.

.Some specimens of *G. fieldiana* were previously identified as *G. pumilio*. Both of these species, as well as *G. beamanii*, have been collected near Xémal, but even in this area they maintain their distinctness. *Gentiana fieldiana* is readily distinguishable from *G. pumilio* by its narrower, less densely crowded leaves with narrower, less prominently denticulate margins, and by the shape of its corolla lobes.

Breedlove 8596 consists of usually large plants with relatively narrow leaves for this species. The general aspect of these plants consequently resembles that of *G. sedifolia*, but their well-developed leaf margins and keels and the position of their stamens clearly identify them as *G. fieldiana.*

4. GENTIANA PUMILIO Standl. & Steyerm., Publ. Field Mus. Nat. Hist., Bot. Ser. 23:76. 1944. Type: GUATEMALA: San Marcos: between San Sebas-

tián and summit of Volcán de Tajumulco, *Steyermark 35489*, Feb 1940 (holotype F!, isotypes MSC!). Figs. 5, 11, 17.



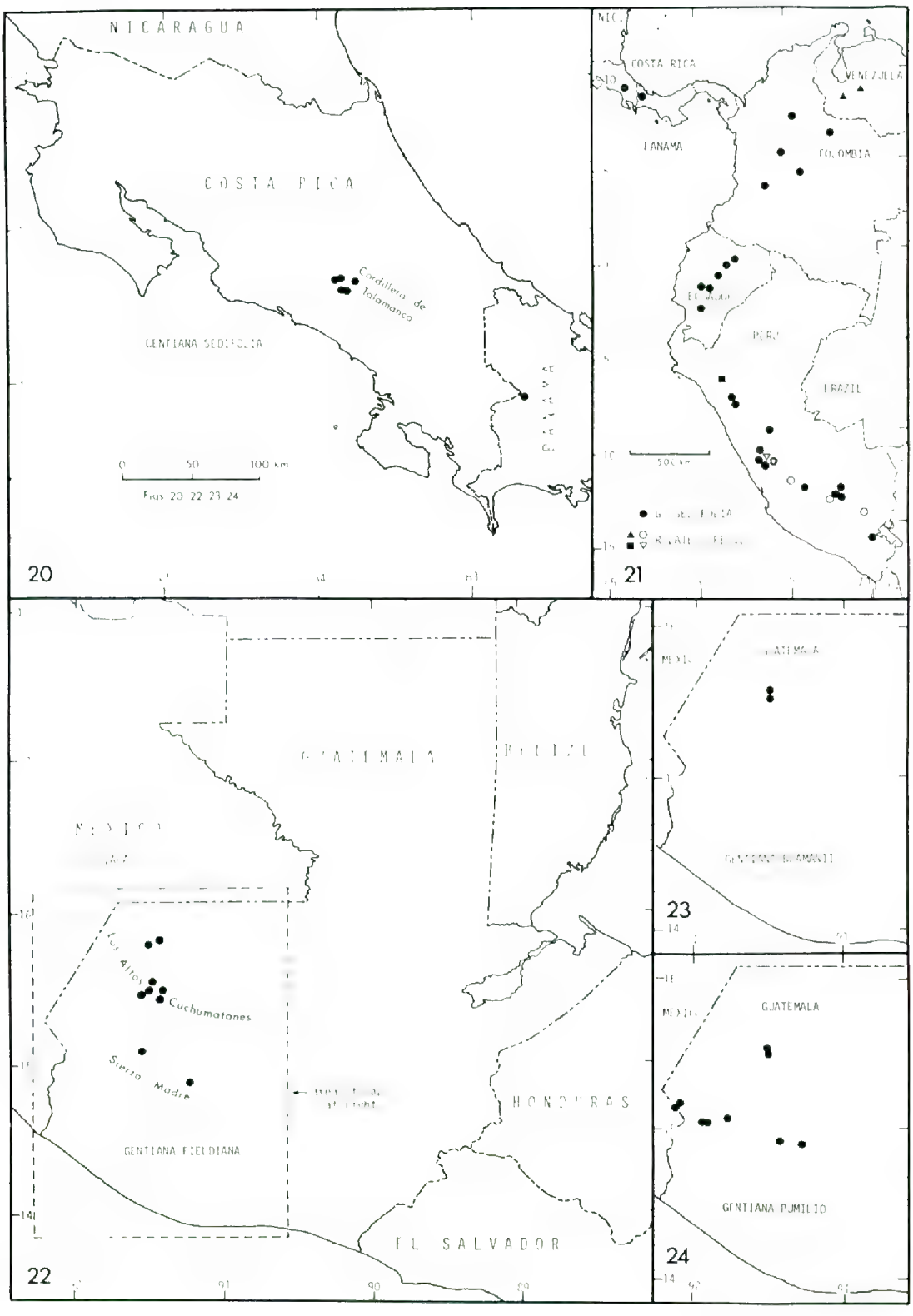
Figs. 14–19. Scanning-electron photomicrographs of pollen grains of *Gentiana* spp. Fig. 14. *G. sedifolia* (*Mulroy 1099*, HAM). Fig. 15. *G. beamanii* (*Beaman 3899*, MSC). Fig. 16. *G. fieldiana* (*Beamon 3071*, MSC). Fig. 17. *G. pumilio* (*Matuda 2868*, MSC). Fig. 18. *G. perpusilla* (*Rzedowski 25681*, MICH). Fig. 19. *G. prostrata* (*Sharp s.n.*, HAM, from Alaska). Figs. 14–19 to same scale.

Plants 0.7–4 cm tall. Stems usually 1–10, sometimes much branched forming dense tufts. Basal and lower cauline leaves persistent and green or the lowest pairs marcescent. Leaves ascending, densely imbricate-crowded on whole length of stem, broadly spatulate to orbicular, either tapering gradually to base or at least upper leaves more commonly abruptly contracted below middle. Larger, lower leaves 2.5–15 mm long, 0.3–1.2 times as wide as long; upper leaves smaller and more strongly ascending but similar in proportions. Apices abruptly acuminate-apiculate. All leaves prominently white-margined and keeled but not strongly conduplicate; margins and keels of upper leaves mostly 0.25–0.35 mm wide, minutely but copiously denticulate at least above middle. Flowers solitary or in clusters of 2–3. Calyx tube largely concealed by leaves, 3–5.5 mm long, carinate distally. Calyx lobes ovate-triangular, erect, strongly carinate-conduplicate, 1–2.3 mm long, 0.5–1.5 mm wide, obtuse, with prominent white margins and keels ca. 0.2 mm wide, denticulate to base. Corollas 5–11 mm long when closed; expanded limb 4–7 mm across. Corolla tube 4–9 mm long. Lobes ovate-triangular, 1–2 mm long, ca. 1.2 times as wide as long, obtuse. Free portions of appendages triangular, ca. 0.6 times as long and 0.8 times as wide as lobes, acute, entire or shallowly undulate. Corolla tube mostly greenish-white; lobes, free portions of appendages, and upper part of tube white to light blue; exterior surface of petals proper moderately to strongly suffused with green, and in blue corollas sometimes with deep violet, the suffusion strongest toward center. Stamens becoming free at ca. 3/5 total height of corolla; free portions (including anthers) ca. 2.2 mm long. Pollen grains spheroidal. Sexine relatively fine striato-reticulate. Style ca. 3 mm long, spiralling in fruit. Capsule 5–7 mm long, 1/2 to almost completely exserted from marcescent corolla. Seeds cylindric-ellipsoid, medium brown, striato-reticulate, ca. 0.9 mm long and 0.3 mm in diameter.

Additional specimens examined:

GUATEMALA: Huehuetenango (all from Los Altos Cuchumantanes): region of Chémal [Xémal], *Standley 81107* (F); cumbre de la Sierra de los Cuchumatanes, between the first cumbre and La Pradera, *Standley 81172* (F); near Calaveras, *Williams et al. 21954* (F) and *21955* (F, NY, US); 3–15 km N of Chémal [Xémal], *Williams et al. 22208* (F). San Marcos: between Sibinal and summit of Volcán Tacaná, *Steyermark 36156* (F); Volcán Tajumulco, *Bunting 337* (F); between Comitancito [Comitancillo] and Santa Rosa junction, Sierra Madre, *Williams et al. 27058* (F); lower slopes of Volcán Tajumulco near San Sebastián, *Plowman 3064* (GH). Sololá: near María Tecún, Sierra Madre, about 10–12 km NW of Los Encuentros, *Williams et al. 27325* (F). Totonicapán: region of Desconsuelo, *Standley 62735* (F); region of Salvachán, mountains above Totonicapán, just before reaching Desconsuelo, *Standley 84489* (F); slopes of María Tecún above Totonicapán, *Williams & Williams 18557* (GH, US); summit of Cerro María Tecún, about 12 km SW of Totonicapán, *Williams et al. 25457* (F); María Tecún, *Molina R. et al. 16376* (F, NY, US). MEXICO: Chiapas: Volcán de Tacaná pico, *Matuda 2868* (F, GH, HAM, K, MEXU, MICH, MSC, NY, US).

Gentiana pumilio is native to the Sierra Madre of southwestern Guatemala



Figs. 20-24. Documented distribution of *Gentiana* spp.

and adjacent Chiapas, Mexico, and to Los Altos Cuchumantanes in Guatemala. All collections of this species are from open habitats, mostly in subalpine or alpine zones, from ca. 2500 to 4062 m. Most collections are from moist sites, but some are from dry slopes and pastures. Plants have been collected in flower from November through May.

Because of its proportionately wide leaves and the wide and conspicuous white margins and keels of its leaves and calyx lobes, *G. pumilio* is readily distinguishable from the other species described here. Its relatively long style and spheroidal pollen grains are also distinctive. *Gentiana pumilio* further differs from the three preceding species in that the flowers are often borne in clusters of two or three, rather than singly at the ends of branches.

5. GENTIANA PERPUSILLA Brandegee, Zoe 5:181. 1904. Type: MEXICO: México: Ixtaccíhuatl, *Purpus 302*, Mar-Jul 1903 (holotype US!, isotypes F!, GH!, MO!, MSC!, UC). Figs. 6, 12, 18.

Plants 0.8–3 cm tall. Stems 1–10, ascending, not branched except occasionally near base. Leaves short-acuminate, apiculate. Basal leaves mostly in good condition at flowering time, obovate to broadly spatulate, moderately ascending, scarcely to moderately conduplicate, 4–10 mm long, 1.8–3.5 mm wide. Cauline leaves densely crowded, increasingly conduplicate and more strongly ascending upward, those near summit of stem oblanceolate, 3–6 mm long, 1–2.5 mm wide. White leaf margins and midrib keel inconspicuous, ca. 0.05 mm wide, entire or with a few shallow projections near apex. Calyx tube 4–6.5 mm long, carinate distally. Calyx lobes triangular, erect, 1–1.2 mm long, 0.7–1 mm wide, acute, with white margins and keels ca. 0.08 mm wide, entire. Corollas 5–9.5 mm long when closed; expanded limb 3.5–4.5 mm across. Corolla tube 4–8.5 mm long. Lobes ovate-triangular, 1–2 mm long, about as wide as long, subacute. Free portions of appendages triangular, ca. 0.67 times as long and about as wide as lobes, subacute to acute, entire, merely undulate, or shallowly few-toothed. Corolla tube mostly greenish-white; lobes and free portions of appendages pale to medium blue; exterior surface of lobes, except near margins, and adjacent portions of tube strongly suffused with green. Stamens becoming free at ca. 2/3 total height of corolla; free portions (including anthers) 1.5–2 mm long. Pollen grains prolate. Sexine relatively finely striato-reticulate. Style almost obsolete. Capsule 2.5–3.5 mm long, 1/2 to entire length and up to 3 mm of gynophore exserted from marcescent corolla. Seeds ovoid-ellipsoid, brownish-white, striato-reticulate, ca. 0.75 mm long, 0.5 mm in diameter.

Additional specimens examined:

MEXICO: México (all from the SW side of Ixtaccíhuatl): Cañada de Alcalican (Tlaltapitongo) below La Joya, *Beaman 3534* (MSC); La Joya, Cañada de Alcalican, *Rzedowski 21594* (ENCB) and *25681* (ENCB, MICH, MSC); in canyon below end of auto road, ca. 2.4 km N of microwave tower, *J.S. Pringle 1749* (HAM). Veracruz: Cofre de Perote, NW side of mtn., *Beaman 2197* (GH, MSC).

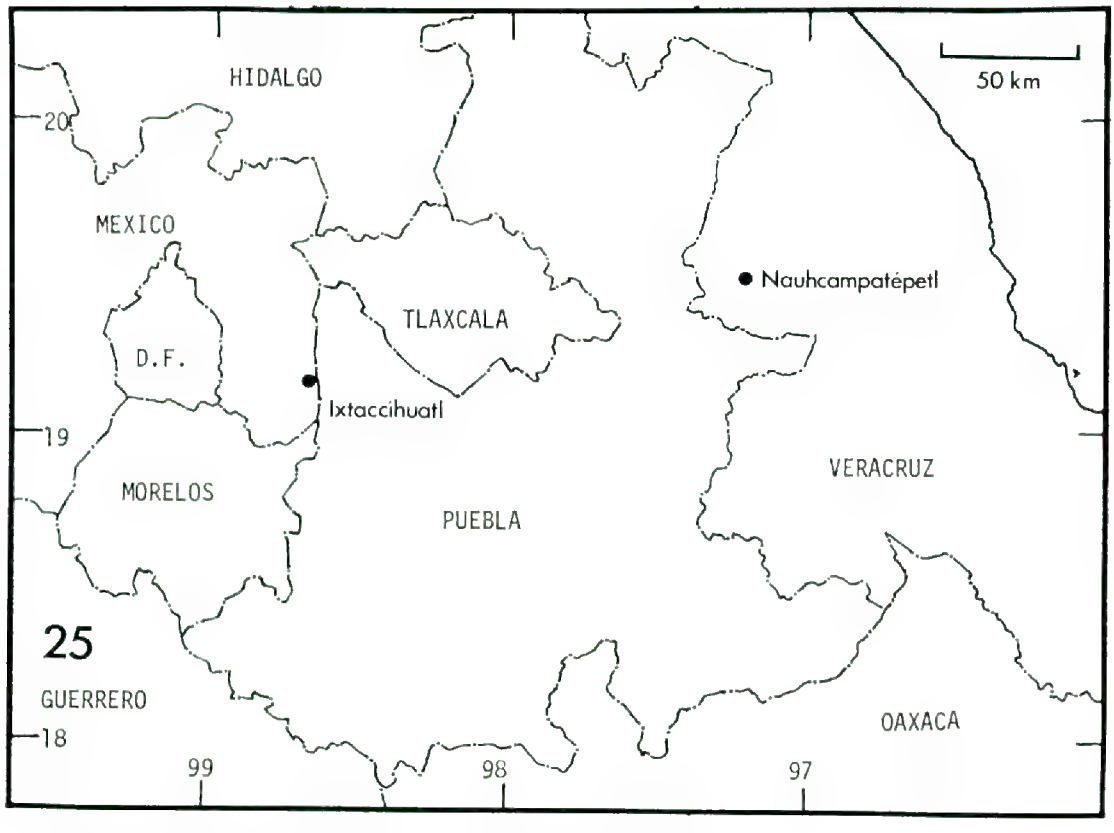


Fig. 25. Documented distribution of *Gentiana perpusilla*.

The two localities known for *G. perpusilla* are on peaks in the Transverse Volcanic Zone of Mexico (Fig. 25). It grows in the alpine zone at ca. 3850 m on Ixtaccíhuatl and 3590 on Nauhcampatépetl (Cofre de Perote), in microhabitats that are wet at least in summer.

Among the species described here, *G. perpusilla* has by far the smallest corollas, and its pollination appears probably to be largely hygrocleistogamous. It grows where fog and drizzle are nearly continuous during its flowering season, and consequently its photonastic corollas are infrequently and briefly open. Observation of pollen in preserved flowers from Ixtaccíhuatl indicated that dehiscence of the anthers into the small space within a closed corolla can readily bring pollen into contact with the stigmatic lobes. In one corolla, however, the presence of a few alien grains indicated that some chasmogamous pollination does occur.

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cooperation and assistance with field work; Messrs. James Darley and Douglas Brown, for SEM photographs of pollen grains, using facilities at McMaster University; the curators and staff of the herbaria listed in the introduction of this paper, for making specimens available for study; the Consejo Nacional de Ciencia y Tecnología, for permission to collect specimens of *Gentiana* in Mexico; and the Board of the Royal Botanical Gardens, for its support of the publication of this paper.

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REVISION OF NORTH AND CENTRAL AMERICAN *NAJAS* (NAJADACEAE)[1]

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Najas is a cosmopolitan genus of submerged aquatic plants with its greatest diversity in tropical and subtropical regions. In North America, individuals of the genus can be separated from other aquatic genera by the plants of *Najas* possessing sub-opposite serrulate leaves and axillary imperfect flowers. Although floristic treatments have been prepared for certain areas—e.g., eastern United States (Clausen 1936) and Panama (Wentz and Haynes 1973)—at no time since Rendle (1901) have all the species, either world-wide or regional, been included in one revisionary treatment. Morphological variability within the group has been poorly understood. Because of the lack of a thorough revisionary treatment and a poor understanding of the taxa, the genus is, I believe, in need of revision.

The genus *Najas* has been divided into two subgenera, *Najas* and *Caulinia*, by Ascherson (1864) with *Najas* being dioecious and *Caulinia* being monoecious. Magnus (1889) separated subgenus *Caulinia* into two sections, *Americanae* with sloping leaf sheaths and *Euvaginatae* with truncate to auriculate leaf sheaths. Rendle (1899) divided the subgenus into two more sections, *Spathaceae* with staminate and carpellate flowers enclosed in floral envelopes and *Nudae* with no flowers enclosed in floral envelopes. According to Rendle (1899), the sections *Americanae* and *Euvaginatae* were composed of plants with staminate flowers enclosed in floral envelopes and carpellate flowers without such envelopes. Wilde (1961), in an investigation of Asiatic and Malaysian species of *Najas*, determined the presence of the envelopes to be too inconsistent to segregate sections. He thus proposed the abolition of Rendle's sections.

Variation in vegetative parts (plasticity) within individual taxa of aquatic plants has been recognized in *Callitriche* (Fassett 1951), *Halodule* (Phillips 1967), *Nymphaea* (Williams 1970), *Najas minor* (Wentz & Stuckey 1971), and *Potamogeton* (Haynes 1974). These workers concluded that because of this plasticity, the taxonomy of the genera in question should rest primarily on reproductive characters. As a result of my field work and the examination of several thousand herbarium specimens, I have found considerable plasticity within the leaf sheaths of *Najas*. I have concluded, therefore, that the separation of sections based upon the shape of the auricles is super-

[1] Paper No. 7 from the Aquatic Biology Program, The University of Alabama.

SIDA 8(1): 34–56. 1979.

ficial. I agree with Wilde that four sections are unwarranted. Wilde (1961) also suggested that the two subgenera be reduced to sections because of the "great resemblance of *N. marina* to other species of *Najas* . . . ." I agree that *N. marina* resembles the other species. However, with *N. marina* being dioecious, having a testa several cell layers thick, and having prickly internodes and dorsal surface of the laminae—the other species are monecious, have a testa three cell layers thick, and do not have prickly internodes and dorsal surfaces of the laminae—I believe the subgeneric category to be warranted.

The nomenclature of *Najas* is difficult. Many of the taxa in North and Central America were named by Sprengel (1825), Braun (1864), and Magnus (1870, 1894). The specimens examined by these workers were deposited at Berlin and later were destroyed during World War II. Gerloff (personal communication) informs me that no pre-World War II specimens of *Najas* (including the Willdenow collection) remain at Berlin. Therefore, I have had to resort to published descriptions and accepted usage of many names. In some instances (see Haynes and Wentz 1974) when only one or two taxa of *Najas* occur in an area, there is good evidence for my decision. In others, however, I have only the accepted usage and description to follow.

The morphology, systematic relationships, and economic value of *Najas* were discussed by Haynes (1977). Evidence from field work has indicated that *Najas* is just as morphologically plastic as *Callitriche* (Fassett 1951), *Potamogeton* (Haynes 1974), and *Ranunculus* (Bostrack and Millington 1962). Just as workers in these other genera have resorted to reproductive characters as a basis of a classification, I believe that a classification based mostly on reproductive structures is the only one workable for *Najas*. One should always attempt to collect specimens of *Najas* with seeds (Fig. 8). Just as identification of a sterile *Aster* may be nearly impossible, it is difficult at best to determine a sterile *Najas*.

The treatment that follows is based on field study and an examination of approximately 5000 herbarium specimens from 35 North American and European herbaria: A, ALU, AUA, B, BH, CAN, DAO, F, FSU, GA, GH, JEPS, K, KANU, KNK, LAF, LSUS, MEXU, MICH, MIN, MO, NCSC, NY, OS, PH, TENN, UC, UNA, UNC, UMBS, US, USF, UTC, VDB, and WIS (abbreviations according to Holmgren and Keuken 1974). Keys are based upon materials containing seeds; dimensions of leaves are taken from the fully expanded; longest leaves of a specimen; measurements of widths are taken approximately at the widest point of the leaf; and descriptions of the seeds are taken strictly from mature structures (Fig. 8).

NAJAS Linnaeus, Sp. Pl. 2: 1015. 1753; Gen. Pl. ed. 5. 445. 1754.

Caroliana Raf., J. Phys. Chim. Hist. Nat. Arts 89:259. 1819.
Caulinia Willd., Mèm. Acad. Roy. Sci. Hist. (Berlin) 87. 1798.
Fluvialis Adans., Fam. Pl. 2:472. 1763.
Hyas Dumort., Anal. Fam. Pl. 61. 1829.
Ittnera C. C. Gmel., Fl. Bad. 3:590. 1808.

Plants glabrous, herbaceous, annual or rarely perennial, aquatic, submersed in fresh or brackish waters, monoecious or dioecious. Stems slender, much branched, rooting at the lower nodes, sometimes armed with prickles on the internodes. Leaves subopposite or appearing whorled due to reduced internode length, sessile, each divided into lamina and sheath. Laminae linear and flattened, 1–nerved, sometimes dorsally armed with prickles on the midrib; margins usually serrulate with 5–100 teeth per side; apex acute to acuminate, with 1–3 teeth per side; teeth multicellular, formed by layers of cells decreasing in cell number outward terminated by a large, sharp-tipped cell, or unicellular. Sheaths variously shaped, each enclosing a pair of tiny hyaline scales; margins usually toothed with 1–15 teeth per side. Flowers imperfect, axillary, sessile or short pedunculate, solitary or clustered, often subtended by an involucre; involucre clear, bronze, brown, light green, purple, or red-purple. Staminate flowers subtended by a membranous involucre or the involucre rarely absent, each consisting of a single stamen; peduncle at first short, elongating at anthesis, pushing the anther through the involucre; anther sessile, 1– or 4–loculed, dehiscing irregularly; pollen 3–celled, globular or ellipsoid, densely filled with starch, monocolpate, the wall with shallow reticulations, thin, not divided into exine and entine. Carpellate flowers sessile, 1–loculed, 1–ovuled; involucre absent or rarely present; ovule basal, anatropous, with 2 integuments; gynoecial wall 2 cell layers thick, ending in a short style with 2–4 branches. Fruit 1–seeded, dehiscing by decay of gynoecial wall; gynoecial wall extremely delicate, closely enveloping the seed. Seeds without endosperm, areolate, with a basal raphe, fusiform to obovate, occasionally asymmetrical at apex or recurved; testa hard, brittle, 3 or several cell-layered, pitted or smooth; areolae formed by outer two layers of testa, variously rectangularly shaped, irregularly arranged or in 15–60 rows, the end walls often raised, giving the testa a papillose appearance; embryo elongate, without lateral enlargement of cotyledons. TYPE SPECIES: *N. marina* L. (From the Greek, *naias*, a water-nymph.)—Bushy-pondweed, Naiad, Water-Nymph.

KEY TO THE TAXA

1. Plants dioecious; testa pitted, 4 or more cell layers thick; internodes and dorsal surfaces of lamina with prickles; seeds 1.2 mm wide or wider ..... 1. *N. marina*
1. Plants monoecious; testa smooth or pitted, 3 cell layers thick; internodes and dorsal surface of lamina without prickles; seeds 1.2 mm or less wide, *if* 1.2 mm wide, *then* with smooth testa 2
   2. Seeds asymmetrical at apex or recurved 3
      3. Areolae broader than long, ladder-like; teeth multicellular ..... 7. *N. minor*
      3. Areolae longer than broad, never ladder-like; teeth unicellular 4
         4. Seeds strongly recurved; areolae in 10–20 rows; leaves in age stiff, recurved ..... 6. *N. ancistrocarpa*
         4. Seeds asymmetrical at apex but not recurved; areolae in 35–45 rows; leaves in age limp and spreading to ascending ..... 5. *N. gracillima*
   2. Seeds symmetrical at apex, not recurved 5

5. Lamina teeth unicellular, (18–) 30–100 per side 6
6. Testa smooth, glossy; seeds obovate, brown to yellow; anthers 1–loculed ..... 2. *N. flexilis*
6. Testa pitted, dull; seeds fusiform, yellowish-white to greenish-brown; anthers 1– or 4–loculed 7
7. Leaf sheaths deeply auriculate; restricted in North America to California ..... 4. *N. graminea*
7. Leaf sheaths rounded to truncate; widespread 8
8. Seeds 3.3–3.8 mm long; areolae arranged in 50–60 rows ..... 3d. *N. guadalupensis var. muenscheri*
8. Seeds 2.5 mm or less long; areolae in fewer than 50 rows 9
9. Teeth evident to unaided eye; anthers 1–loculed ..... 3c. *N. guadalupensis var. floridana*
9. Teeth invisible to unaided eye; anthers 4–loculed 10
10. Laminae with 50–100 teeth per side; stems 0.8 mm or less in diameter ..... 3a. *N. guadalupensis var. guadalupensis*
10. Laminae with less than 50 teeth per side; stem 1.0 mm or more in diameter ..... 3b. *N. guadalupensis var. olivacea*

5. Lamina teeth multicellular, 5–25 per side 11
11. Seeds 2 mm long or longer; areolae arranged in ca. 50 rows, elongate; teeth shorter than rest of the lamina is wide ..... 9. *N. arguta*
11. Seeds less than 2 mm long; areolae arranged in ca. 20 rows, 5–sided, all sides about equal; teeth longer than rest of lamina is wide ..... 8. *N. wrightiana*

NAJAS subgenus NAJAS

Plants dioecious. Stem slender, much branched, rooting at the lower nodes, usually armed with prickles on the internodes. Leaves subopposite or appearing whorled, sessile; laminae coarsely serrate, the teeth multicellular, the midrib with prickles. Flowers solitary; anthers 4–loculed. Seeds 2.2–4.5 mm long; testa several (more than 3) cell layers thick; areolae arranged irregularly. Species 1. TYPE SPECIES: *N. marina* L.

1. NAJAS MARINA L., Sp. Pl. 2: 1015. 1753.

Ittnera major C. C. Gmel., Fl. Bad. 3:590. 1808.
I. najas C. C. Gmel., Fl. Bad. 3:590. 1808.
Najas gracilis Morong, Mem. Torrey Bot. Club 3(2):61. 1893.
N. gracilis Small, Fl. Southeastern U. S. 40. 1903.
N. latifolia A. Br., J. Bot. 2:276. 1864.
N. latior F. Muell. ex K. Schum. in Martius, Fl. Brasiliensis 3(3):804. 1894.
N. marina var. *angustifolia* (A. Br.) K. Schum. in Martius, Fl. Brasiliensis 3(3):725. 1894.
N. marina var. *angustissima* K. Schum. in Martius, Fl. Brasiliensis 3(3):725. 1894.
N. mariana var. *bollei* K. Schum. in Martius, Fl. Brasiliensis 3(3):726. 1894.
N. marina var. *brevifolia* Rendle, Trans. Linn. Soc. London, Bot. 5:396. 1899.
N. marina var. *californica* Rendle, Trans. Linn. Soc. London, Bot. 5:398. 1899.
N. marina var. *denticulata* Rendle, Trans. Linn. Soc. London, Bot. 5:438. 1900.
N. marina var. *ehrenbergii* (A. Br.) K. Schum. in Martius, Fl. Brasiliensis 3(3):276. 1894.
N. marina var. *genuina* K. Schum. in Martius, Fl. Brasiliensis 3(3):724. 1894.
N. marina var. *gracilis* (Morong) Dudley, Cornell Univ. Sci. Bull. 2:104. 1886.

N. marina var. *latifolia* (A. Br.) K. Schum. in Martius, Fl. Brasiliensis 3(3):725. 1894.
N. marina var. *latior* F. Muell. ex K. Schum. in Martius, Fl. Brasiliensis 3(3):725. 1894.
N. marina var. *mexicana* Rendle, Trans. Linn. Soc. London, Bot. 5:398. 1899.
N. marina var. *multidentata* (A. Br.) K. Schum. in Martius, Fl. Brasiliensis 3(3):726. 1894.
N. marina var. *muricata* (Raffeneau-Delile) K. Schum. in Martius, Fl. Brasiliensis 3(3):725. 1894.
N. marina var. *paucidentata* (A. Br.) K. Schum. in Martius, Fl. Brasiliensis 3(3):726. 1894.
N. marina var. *recurvata* Dudley, Cornell Univ. Sci. Bull. 2:104. 1886.
N. major All., Fl. Pedem. 2:221. 1785.
N. major var. *angustifolia* A. Br., J. Bot. 2:275. 1864.
N. major var. *ehrenbergii* A. Br., J. Bot. 2:275. 1864.
N. major var. *gracilis* Morong, Bot. Gaz. (Crawfordsville) 10:225. 1885.
N. major var. *intermedia* A. Br., J. Bot. 2:276. 1864.
N. major var. *microcarpa* A. Br., J. Bot. 2:276. 1864.
N. major var. *multidentata* A. Br., J. Bot. 2:275. 1864.
N. major var. *paucidentata* A. Br., J. Bot. 2:276. 1864.
N. muricata Raffeneau-Delile, Descr. Egypte, Hist. Nat. 281. 1813.

Plants dioecious. Stems 6–45 cm long, 0.5–4.0 mm in diameter, branched upward; internodes 0.3–11.0 cm long, with or without prickles. Leaves 0.5–3.9 cm long; laminae spreading to ascending, 0.4–4.5 mm wide, acute with 1 tooth at apex, coarsely serrate with 8–13 teeth per side, the terminal teeth similar in size and structure to the lateral teeth, the teeth multicellular, the midrib with prickles; sheaths 2.0–4.4 mm wide, wider than the laminae, acute, the teeth similar in size and structure to those of the laminae. Flowers solitary, the involucre brown to slightly purple; staminate flowers 1.7–3.0 mm long, the involucre beaks 0.3–0.7 mm long, 2–lobed, the anther 1.7–3.0 mm long, 4–loculed; carpellate flowers 2.5–5.7 mm long, the style 1.2–1.7 mm long, the stigma 3–lobed. Seeds 2.2–4.5 mm long, 1.2–2.2 mm wide, reddish brown, ovoid, the testa pitted, the areolae 3–4-angled, ca. 0.2 mm long, 0.1 mm broad, irregularly arranged, the end walls slightly raised (Fig. 8A). Chromosome number, $2n = 12$ (Viinikka 1973).

Brackish or highly alkaline waters of ponds and lakes, North and South Dakota to western New York; California to Utah, south to Panama; Florida and Caribbean islands (Fig. 1).

TYPE: Europe maribus (Holotype: LINN; Microfiche #1156 IDC 1945. 682:II 6, 7).

With its prickly internodes and prickles along the undersurface of the leaves, *N. marina* is the easiest of our *Najas* to recognize. The species is variable in the size of leaves, teeth, and seeds and, as a result, has been divided into numerous varieties. These differences usually can be found within single populations and, therefore, do not warrant taxonomic recognition. Viinikka (1973), however, observed two cytological races of the species, one race with B chromosomes and one without these accessory chro-

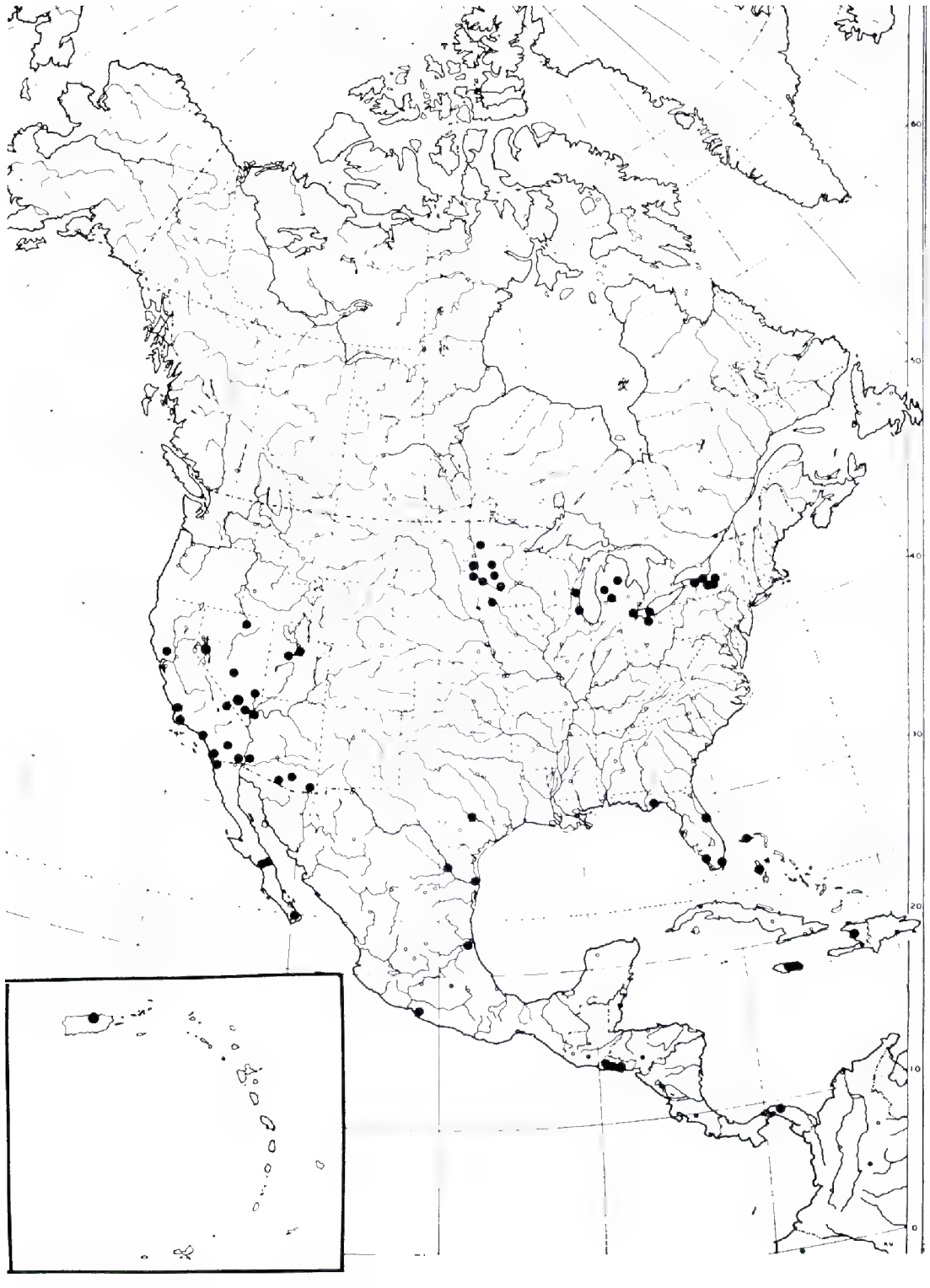


Fig. 1. Map of North America showing the documented distribution of *Najas marina*. (Caribbean islands inserted.)

mosomes. He examined one population from North America (Erie County, Ohio) and observed B chromosomes from those individuals (personal correspondence). He indicated (personal correspondence) that, in Europe, plants from the two races are morphologically different. Specimens with large seeds and leaves (no size given) invariably do not possess B chromosomes, whereas those with smaller seed and leaves do possess B chromosomes. He has not yet determined how to rank these apparent entities.

NAJAS subgenus CAULINIA (Willd.) Aschers., Fl. Prov. Brandenburg I:670. 1864.

Plant monoecious. Stem slender, much branched, rooting at the lower nodes, the internodes without prickles. Leaves subopposite or appearing whorled, sessile; laminae minutely serrulate to serrate, the teeth unicellular or multicellular, the midrib without prickles. Flowers solitary or clustered; anthers 1– or 4–loculed. Seeds 0.7–3.8 mm long; testa 3 cell layers thick; areolae arranged in longitudinal rows. Species 2–9. LECTOTYPE SPECIES: *Caulinia flexilis* Willd. = *N. flexilis* (Willd.) Rostk. & Schmidt. (Lectotype here designated.)

2. NAJAS FLEXILIS (Willd.) Rostk. & Schmidt, Fl. Sedin. 382. 1824.

Caulinia flexilis Willd., Mem. Acad. Roy. Sci. Hist. (Berlin) 95. 1798.
Fluvialis flexilis (Willd.) Pers., Synops. 2:530. 1807.
Najas canadensis Michx., Fl. Bor. Amer. 2:220. 1803.
N. caespitosus (Maguire) Reveal in Welsh, Atwood, & Reveal, Great Basin Naturalist 35:357. 1976.
N. flexilis subsp. *caespitosa* Maguire & Jensen, Rhodora 44:7. 1942.
N. flexilis var. *congesta* Farwell, Rep. Michigan Acad. Sci. 21:348. 1920.
N. flexilis var. *robusta* Morong, Bot. Gaz. (Crawfordsville) 10:255. 1885.

Plants monoecious. Stems 2.5–50 cm long, 0.2–0.6 mm in diameter, often profusely branched above; internodes 0.16–6.8 cm long, without prickles. Leaves 0.8–4.2 cm long; laminae spreading to ascending, 0.2–0.6 mm wide, acute with 1–2 teeth at apex, minutely serrulate with 35–80 teeth per side, the terminal teeth similar in size and structure to the lateral teeth, the teeth unicellular, the midrib without prickles; sheaths 0.7–1.6 mm wide, wider than the laminae, round, minutely serrulate with 8–10 teeth per side, the teeth similar in size and structure to those of the laminae. Flowers 1 (–2) per axil, the staminate in the upper axils, the carpellate throughout, the involucre bronze; staminate flowers 1.1–2.7 mm long, the involucre beaks 0.7–1.2 mm long, 3–lobed, the anthers 1.1–2.7 mm long, 1–loculed; carpellate flowers 2.5–4.7 mm long, the style 1.5–1.7 mm long, the stigma 3–lobed. Seeds (1.2–) 2.5–3.7 mm long, 0.2–1.2 mm wide, deep brown to yellow, narrowly to broadly obovate, the testa smooth, the areolae 5–6-angled, ca. 0.2 mm long, ca. 0.1 mm wide, in ca. 50 rows, without raised end walls (Fig. 8B). Chromosome number unknown.

Lakes and rivers, Nebraska, Missouri, and Maryland, north to southwestern

Ontario and Newfoundland; Alberta and Saskatchewan south to western Oregon and central Utah (Fig. 2).

TYPE: Pennsylvania (Holotype: B; microfiche # 17094 IDC 7440. 1224: III. 2.)

In habit, *N. flexilis* is most similar to *N. guadalupensis*. However, when seeds are present, *N. flexilis* can be easily separated from the latter species by the glossy, smooth, yellowish seeds that are widest above the middle.

Several different varieties have been proposed for North American individuals of *N. flexilis*, e.g., var. *robusta* Morong, var. *congesta* Farwell, and var. *caespitosa* Maguire and Jensen. These varieties are based, for the most part, on differences in vegetative structures. Clausen (1936), in discussing some of these different forms, stated "Different forms of the species do occur, but the characters, such as width of leaves, size and shape of seeds, and habit, occur in all sorts of combinations and can not be correlated with geographical areas to give definite geographical races or varieties which are worth naming." I have reached the same conclusion.

Najas flexilis is probably the most common *Najas* in the northern United States. Wentz and Stuckey (1971), however, indicated that the species is becoming less common in Ohio. This decrease in abundance apparently corresponds with the increase in turbidity and general decline in water quality of natural lakes and rivers.

3. NAJAS GUADALUPENSIS (Sprengel) Magnus, Beitr. Gatt. *Najas* 8. 1870.

Plants monoecious. Stems 11.0–90.0 cm long, 0.1–2.0 mm in diameter, profusely branched; internodes 0.1–9.0 cm long, without prickles. Leaves 0.3–3.3 cm long; laminae spreading, 0.2–2.1 mm wide, round obtuse to acuminate with 1–3 teeth at apex, minutely serrulate with 18–100 teeth per side, the terminal tooth slightly larger than but similar in structure to the lateral teeth, the teeth unicellular, the midrib without prickles; sheaths 1.0–3.4 mm wide, wider than the laminae, round to slightly auriculate, serrulate with 4–8 teeth per side, the teeth similar in size and structure to those of the laminae. Flowers 1–3 per axil, the staminate in the upper axils, the carpellate in the lower axils, the involucre purple-tinged; staminate flowers 1.5–3.0 mm long, the involucre beaks 0.2–1.3 mm long, 4–lobed, the anther 1.0–1.7 mm long, 1– or 4–loculed; carpellate flowers 1.5–4.0 mm long, the styles 0.3–1.5 mm long, the stigmas 4–lobed. Seeds 1.2–3.8 mm long, 0.4–0.8 mm wide, purple-tinged, fusiform, the testa pitted, the areolae 4–6–angled, 0.08–0.1 mm long, ca. 0.08 mm wide, in 20–60 rows, the end walls not raised. Chromosome number, $2n = 12, 36, 42, 48, 54, 60$ (Chase 1947 a,b).

Najas guadalupensis has long been considered a highly variable species (Fernald 1923). Clausen (1936), Ooststroom (1939), Wentz and Haynes (1973), and Haynes and Wentz (1974) discussed variability within the species and suggested that the complex should possibly be considered as

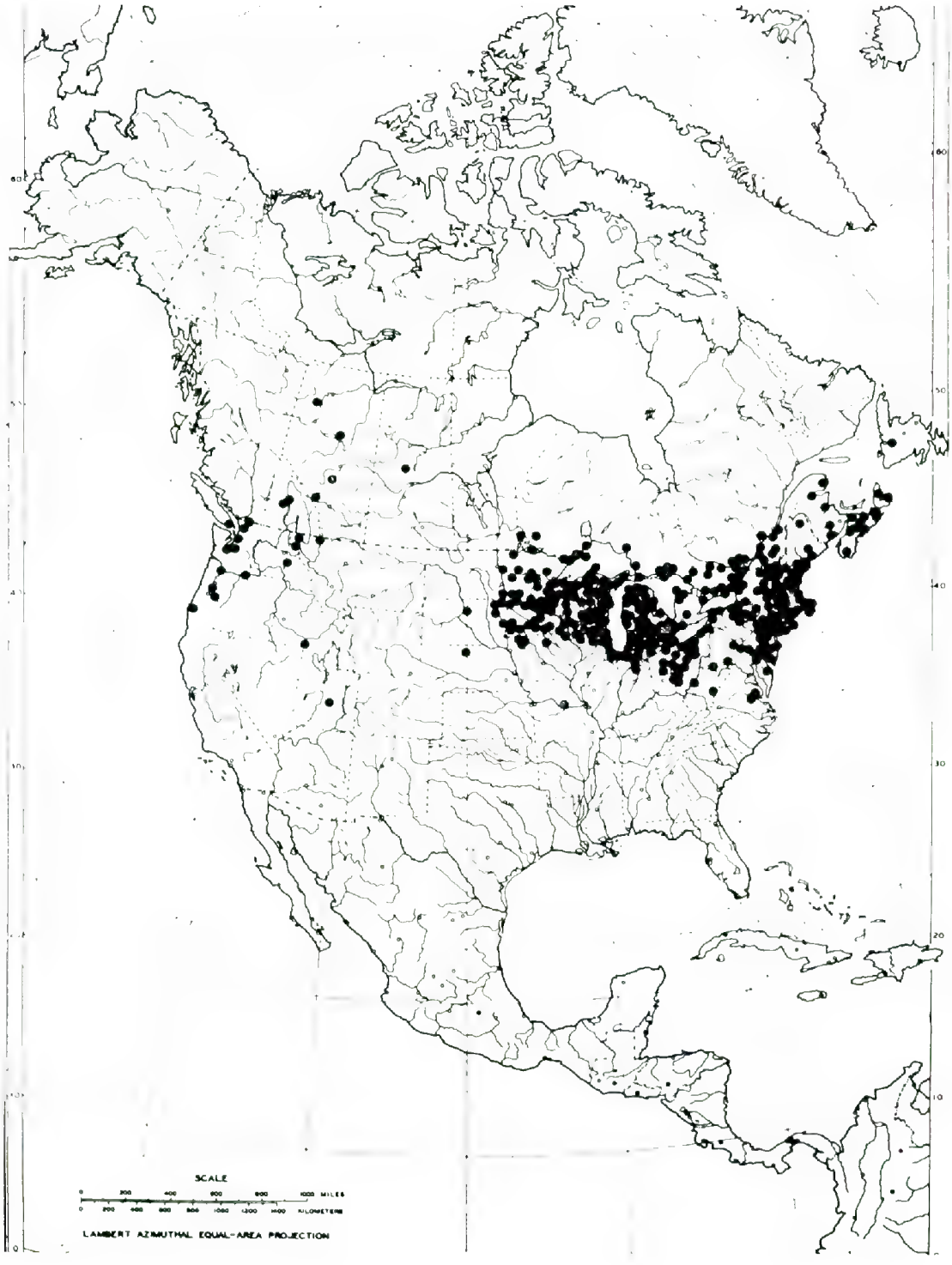


Fig. 2. Map of North America showing the documented distribution of *Najas flexilis*.

several closely related taxa. Rosendahl and Butters (1935) named *N. olivacea.* It was said to differ from *N. guadalupensis* in its stouter habit, its larger seeds, and its testa. Clausen (1937) separated *N. muenscheri* from *N. guadalupensis* by its more slender habit and its seeds with smaller areolae.

From my field work and the examination of thousands of specimens of *N. guadalupensis* and most of these available of *N. muenscheri* and *N. olivacea*, I have concluded that *N. olivacea* and *N. muenscheri* represent populations of *N. guadalupensis* at the northern limit of its range. They are slightly different from most individuals of *N. guadalupensis.* However, intermediates do exist. Thus, I think they should be recognized but do not believe that specific rank is justified. I consider varieties as morphogeographic subdivisions of a species that presumably reflect genetic differences (Kapadia 1963). I have therefore chosen to recognize the taxa that have been called *N. olivacea* and *N. muenscheri* as varieties of *N. guadalupensis.*

By having unicellular teeth on the margin of the lamina, *N. guadalupensis* resembles *N. flexilis* and *N. graminea.* The seeds of *N. guadalupensis* are pitted; those of *N. flexilis* are smooth. The sheaths of *N. guadalupensis* are rounded to slightly auriculate; those of *N. graminea* are deeply auriculate.

3a. NAJAS GUADALUPENSIS var. GUADALUPENSIS

Caulinia guadalupensis Sprengel, Syst. Vegetabilium 1:20. 1824.
Najas flexilis var. *curassavica* A. Br., J. Bot. 2:277. 1864.
N. flexilis var. *fusiformis* Chapman, Fl. Southern U. S. 444. 1883.
N. flexilis var. *guadalupensis* (Sprengel) A. Br., J. Bot. 2:276. 1864.
N. microdon var. *curassavica* A. Br., Sitzb. Ges. Naturf. Fr. Berlin. 1868.
N. microdon var. *guadalupensis* (Sprengel) A. Br., J. Bot. 2:276. 1864.
N. urbaniana O. C. Schmidt, Fedde Rep. Spec. Nov. 22:99. 1925.

Stems 11–75 cm long, 0.1–0.8 mm in diameter. Leaves 0.3–2.8 mm long; laminae 0.2–1.8 mm wide, acute to mucronate, with 50–100 teeth per side; sheaths 1.0–1.9 mm wide, round, with 5–8 teeth per side. Flowers 1–3 per axil; staminate 1.5–2.5 mm long, the involucre beak 0.2–0.6 mm long, the anther elliptic, 4–loculed; carpellate flowers 1.5–2.0 mm long. Seeds 1.2–2.5 mm long, 0.4–0.6 mm wide, the areolae in ca. 20 rows (Fig. 8C).

Lakes, rivers, and canals, southern Maine to southern Alberta and Washington, south to Guadaloupe, Curacao, and Panama (Fig. 3).

TYPE: Guadeloupe (B, destroyed during World War II).

3b. NAJAS GUADALUPENSIS var. **olivacea** (Rosendahl & Butters) Haynes, comb. & stat. nov.

Najas olivacea Rosendahl & Butters, Rhodora 37:347. 1935.

Stems 15–40 cm long, 1.0–2.0 mm in diameter. Leaves 0.9–1.8 cm long; laminae 1.5–2.0 mm wide, acute, with 20–40 teeth per side; sheaths 2.5–3.4 mm wide, round to slightly auriculate, with 4–8 teeth per side. Flowers 1 per axil; staminate flowers 2.3–2.8 mm long, the anther ovoid, 4–loculed; carpellate flowers 2.7–3.1 mm long. Seeds 2.3–2.5 mm long, 0.6–0.8 mm

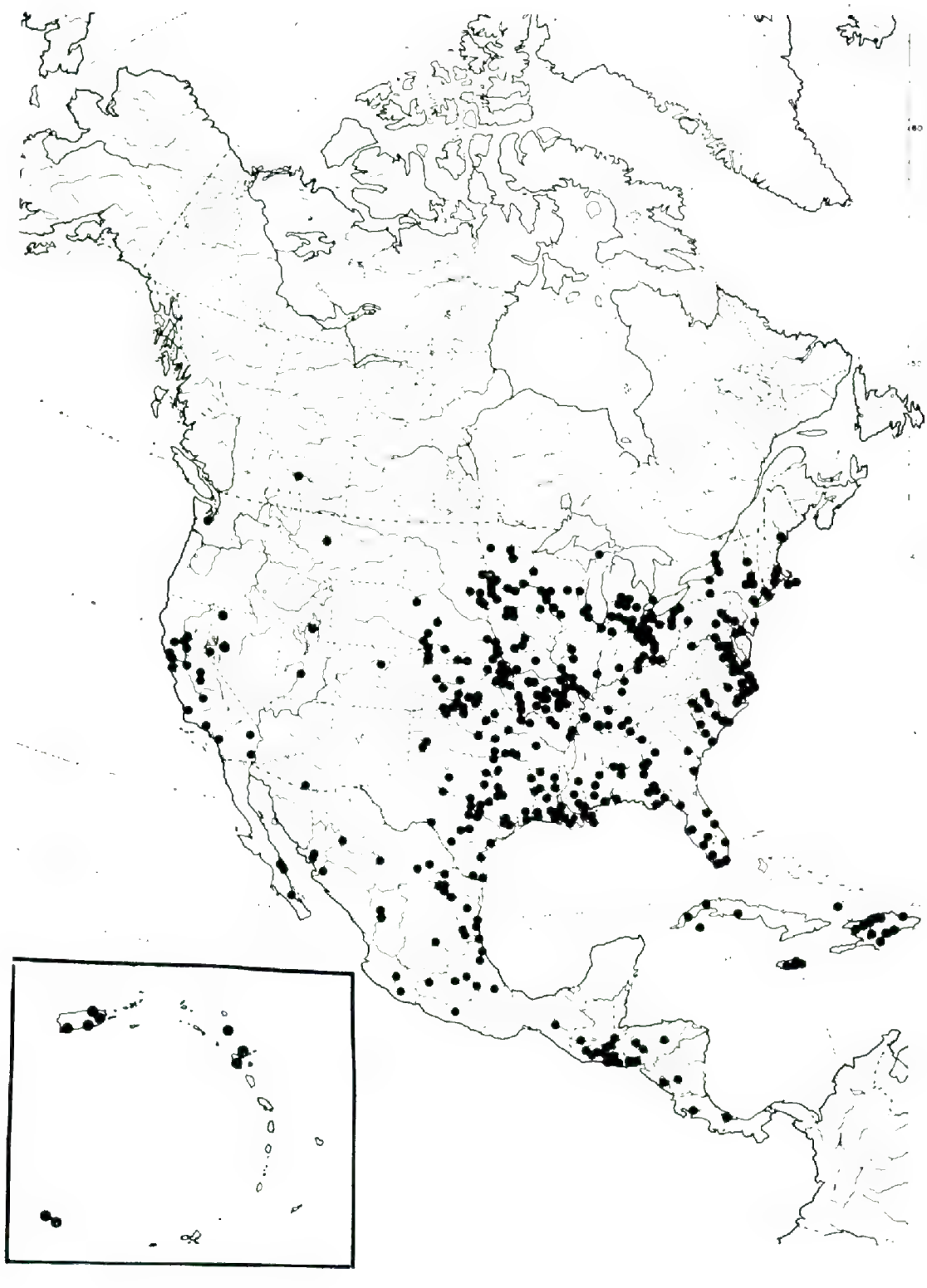


Fig. 3. Map of North America showing the documented distribution of *Najas guadalupensis* var. *guadalupensis*. (Caribbean islands inserted.)

wide, the areolae in 20–40 rows (Fig. 8D).

Lakes and rivers, Iowa to Manitoba, east to New York and Quebec (Fig. 4).

TYPE: UNITED STATES: MINNESOTA: Kandiyohi Co.: growing in tufts in 1–3 feet of water, muddy bottoms; abundant in NE bay of Norway Lake, 6 Sep 1933, *C. O. Rosendahl and F. K. Butters 6446* (Lectotype, MIN!; isolectotype, MIN!). (Lectotype here designated.)

3c. NAJAS GUADALUPENSIS var. FLORIDANA Haynes & Wentz, Sida 5:262. 1974.

Stems 7–51 cm long, 0.1–1.7 mm in diameter. Leaves 0.9–3.3 cm long; laminae 0.5–2.1 mm wide, round obtuse to acuminate, with 18–42 teeth per side; sheaths 1.2–2.5 mm wide, round, with 5–8 teeth per side. Flowers 1 per axil; staminate flowers 1.5–2.4 mm long, the anther elliptic, 1–loculed; carpellate flowers 1.0–3.5 mm long. Seeds 1.6–2.2 mm long, 0.3–0.8 mm wide, the areolae in ca. 20 rows (Fig. 8E).

In lakes, streams, and canals, Florida, central Alabama, and central Georgia (Fig. 4).

TYPE: UNITED STATES: FLORIDA: Dade Co.: abundant in brackish water of ditch along St. Rt. 41 at edge of Everglades National Park, ca. 40 mi. W of Miami, 5 Apr 1972, *W. A. Wentz 670* (Holotype, US!; isotypes, GH!, MICH!, OS!).

3d. NAJAS GUADALUPENSIS var. **muenscheri** (Clausen) Haynes, comb. & stat. nov.

Najas muenscheri Clausen, Rhodora 39:59. 1937.

Stems 30–90 cm long, 0.8–1.0 mm in diameter. Leaves 0.9–1.3 cm long; laminae 0.5–1.6 mm wide, acute, with 50–100 teeth per side; sheaths 1.0–1.5 mm wide, round, with 4–8 teeth per side. Flowers 1 per axil; staminate flowers 2.0–3.0 mm long, the anther elliptic, 1–loculed; carpellate flowers 2.9–4.0 mm long. Seeds 3.3–3.8 mm long, 0.5–0.7 mm wide, the areolae in 50–60 rows (Fig. 8F).

Shallow water of the Hudson River, New York (Fig. 4).

TYPE: UNITED STATES: NEW YORK: Greene Co.: Tidal mudflats of Hudson River, Imbocht Bay, 3 Sep 1936, *W. C. Muenscher and O. F. Curtis, Jr. 5495* (Holotype, BH!; isotype, GH!).

4. NAJAS GRAMINEA Raffeneau-Delile, Descr. Egypte, Hist. Nat. 281. 1813.

Caulina alagensis Pollini, Hort. & Prov. Veron. 26. 1816.
Najas alagensis (Pollini) Pollini, Fl. Veron. 3:49. 1824.
N. seminuda Griff. in Voigt, Hort. Suburb. Calc. 694. 1845.

Plants monoecious. Stems to 35 cm long, 0.2–0.5 mm in diameter, sparingly branched; internodes 0.4–1.9 cm long, without prickles. Leaves 0.8–2.0 cm long; laminae spreading to ascending, 0.5–1.0 mm wide, acute with 2–3

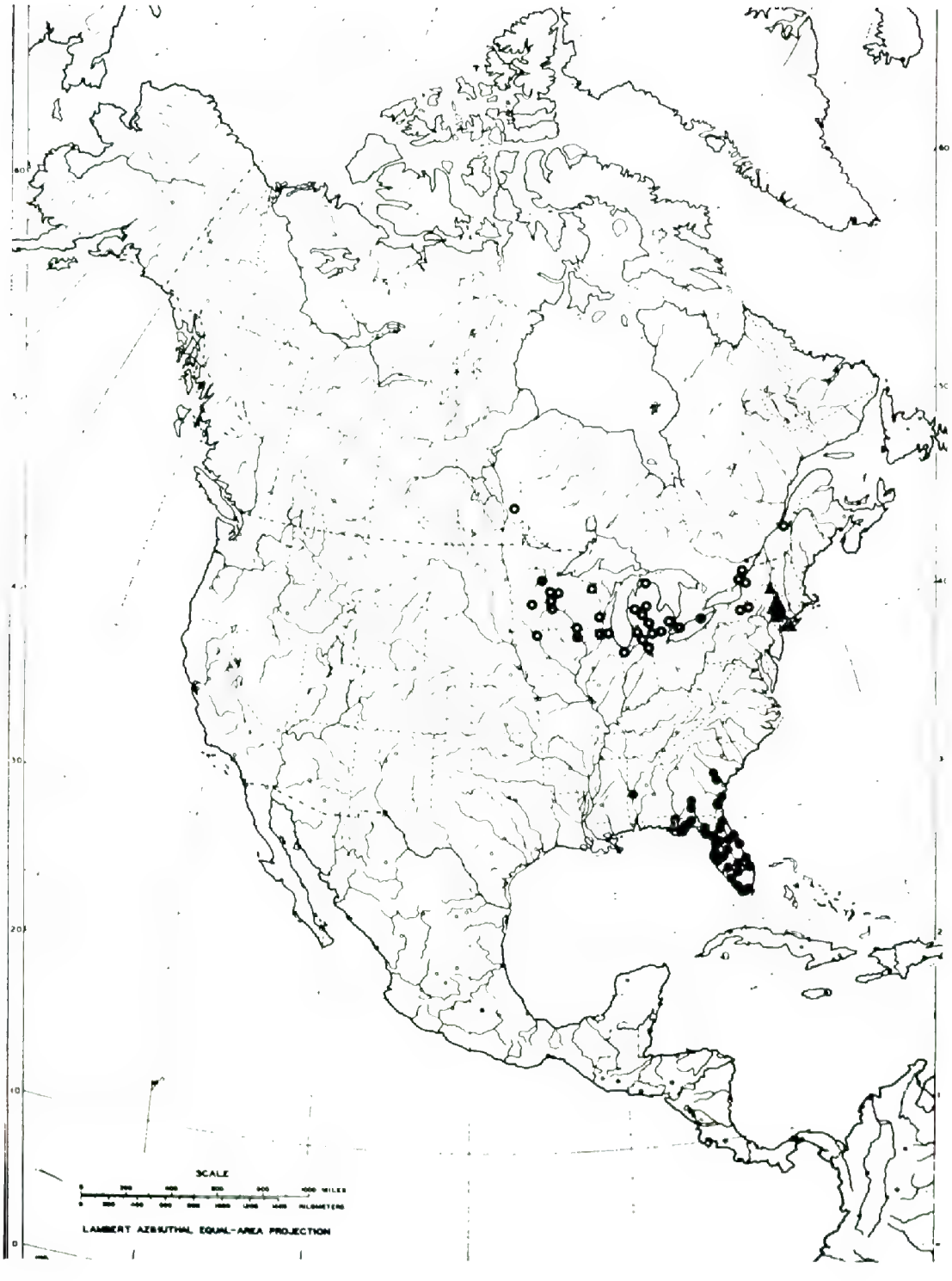


Fig. 4. Map of North America showing the documented distribution of *Najas guadalupensis* var. *floridana* (solid dots), *N. guadalupensis* var. *muenscheri* (solid triangles), and *N. guadalupensis* var. *olivacea* (dots with open star).

teeth at apex, minutely serrulate with ca. 40 teeth per side, the terminal teeth similar in size and structure to lateral teeth, the teeth unicellular, the midrib without prickles; sheaths 1.0–1.5 mm wide, wider than the laminae, deeply auriculate, minutely serrulate with 8–15 teeth per side, the teeth similar in structure and size to those of the laminae. Flowers 1–2 per axil, the staminate in the upper axils, the carpellate throughout, the involucre clear in color; staminate flowers 2.0–3.0 mm long, the involucre beaks 1.0–1.5 mm long, 4–lobed, the anther 1.5 mm long, 4–loculed; carpellate flowers to 3.5 mm long, the styles to 1.0 mm long, the stigmas 2–lobed. Seeds 1.7–2.5 mm long, 0.4–0.6 mm wide, greenish-brown, fusiform, the testa pitted, the areolae 4–angled, less than 0.1 mm long, less than 0.1 mm broad, in ca. 35 rows, the end walls slightly raised (Fig. 8G). Chromosome number, $2n = 48$ (Sharma and Chatterjee 1967).

Rice fields, California (Fig. 5).

TYPE: Egypt (MPU).

By the deeply auriculate sheaths, *N. graminea* is one of the easiest of the North and Central American *Najas* to recognize. A native of southeast Asia, the species apparently was introduced into California prior to 1946 and now is evidently quite rare there. I have seen no recent specimens of the species from North or Central America.

Rendle (1901) placed this species in the section *Nudae* based upon the lack of any floral involucre. Wilde (1961), however, demonstrated the presence of a leaf-like involucre and used this as evidence to abolish the section.

5. NAJAS GRACILLIMA (A. Br. ex Engelm. in A. Gray) Magnus, Beitr. Gatt. *Najas* 23. 1870.

Najas indica (Willd.) Cham. var. *gracillima* A. Br. ex Engelm. in A. Gray, Man. Bot. (ed. 5) 681. 1868.

Plants monoecious. Stems 4.5–48 cm long, 0.2–0.7 mm in diameter, slightly branched; internodes 0.1–3.2 cm long, without prickles. Leaves 0.6–2.8 cm long; laminae spreading to ascending, 0.1–0.5 mm wide, acute with 2–3 teeth at apex, minutely serrulate with 13–17 teeth per side, the terminal teeth similar in size and structure to the lateral teeth, the teeth unicellular, the midrib without prickles; sheaths 0.5–1.5 mm wide, wider than the laminae, truncate, minutely serrulate with 7–8 teeth per side, the teeth similar in size and structure to those of the laminae. Flowers 1–3 per axil, the staminate in the upper axils, the carpellate throughout, the involucre bronze to purple; staminate flowers 1.5–2.0 mm long, the involucre beaks ca. 0.8 mm long, 2–lobed, the anther ca. 1.3 mm long, 1–loculed; carpellate flowers 0.5–2.7 mm long, the styles 0.3–1.5 mm long, the stigmas 2–lobed. Seeds 2.0–3.2 mm long, 0.4–0.7 mm wide, light brown, fusiform with the style arising from one side at the apex, the testa pitted, the areolae 4–angled, less than 0.1 mm long, less than 0.1 mm wide, in ca. 40 longitudinal rows,

Fig. 5. Map of North America showing the documented distribution of *Najas graminea* (solid square), *N. ancistrocarpa* (dots with open star), *N. arguta* (solid triangles), and *N. wrightiana* (solid dots).

the end walls raised (Fig. 8H). Chromosome number unknown.

In soft water lakes, Nova Scotia to Alabama, west to Minnesota and Missouri; California (Fig. 6).

TYPE: Northeast United States (B, destroyed during World War II).

Najas gracillima is most similar to *N. minor*, especially in vegetative condition (see discussion under *N. minor*). *Najas gracillima*, however, can be separated from the latter species by its style arising off-center at the apex of the gynecial wall and by its areolae being longer than broad.

The species, once more common than it is now (Wentz and Stuckey 1971), apparently cannot tolerate pollution and has become exceedingly rare due to the gradual degradation of lakes and streams in eastern United States.

6. NAJAS ANCISTROCARPA Magnus, Beitr. Gatt. *Najas* 7. 1870.

Plants monoecious. Stems 7–22 cm long, 0.2–1.0 mm in diameter, profusely branched; internodes 0.2–4.0 cm long, without prickles. Leaves 0.8–2.6 cm long; laminae usually recurved with age, 0.1–0.7 mm wide, acute with 1 tooth at apex, conspicuously serrulate with 5–9 teeth per side, the terminal tooth slightly larger than but similar in structure to the lateral teeth, the teeth multicellular, the midrib without prickles; sheaths 1.0–1.3 mm wide, wider than the laminae, round to slightly auriculate, serrulate with 3–5 teeth per side, the teeth similar in structure and size to those of the laminae. Flowers 1 per axil, the staminate in the upper axils, the carpellate in the lower axils, the involucre bronze colored; staminate flowers 2.0–3.0 mm long, the involucre beaks ca. 0.4–0.6 mm long, 4–lobed, the anther 1.5–2.0 mm long, 4–loculed; carpellate flowers to 2.5 mm long, the styles less than 0.4 mm long, the stigmas 4–lobed. Seeds 2.5–3.0 mm long, 0.5–0.7 mm wide, greenish-brown, recurved, the testa pitted, the areolae 4–angled, to 0.2 mm long, ca. 0.05 mm broad, in ca. 20 longitudinal rows, the end walls raised (Fig. 8I). Chromosome number unknown.

In lakes, southern Georgia and northern Florida (Fig. 5).

TYPE: JAPAN: *Yokohama* (B, destroyed during World War II).

Najas ancistrocarpa, according to Rendle (1901) and Miki (1935), is exceedingly rare and has been known only from three Japanese islands, Honshiu, Shikoku, and Yokohama. The species is either not as restricted as it was once thought to be or it is spreading. Yang (1974) reported it new to Taiwan, and Haynes and Wentz (1974) recorded it for North America.

The species is known from four localities in North America: Open Pond and Cane Water Pond in Decatur County, Georgia; Milton in Santa Rosa County, Florida; and Lake Jackson in Leon County, Florida. This species is another of the many found in southeastern United States and southeastern Asia (Graham 1972).

The vegetative organs of *N. ancistrocarpa* resemble those of *N. minor* and *N. wrightiana* by the presence of large teeth scattered along the margin of

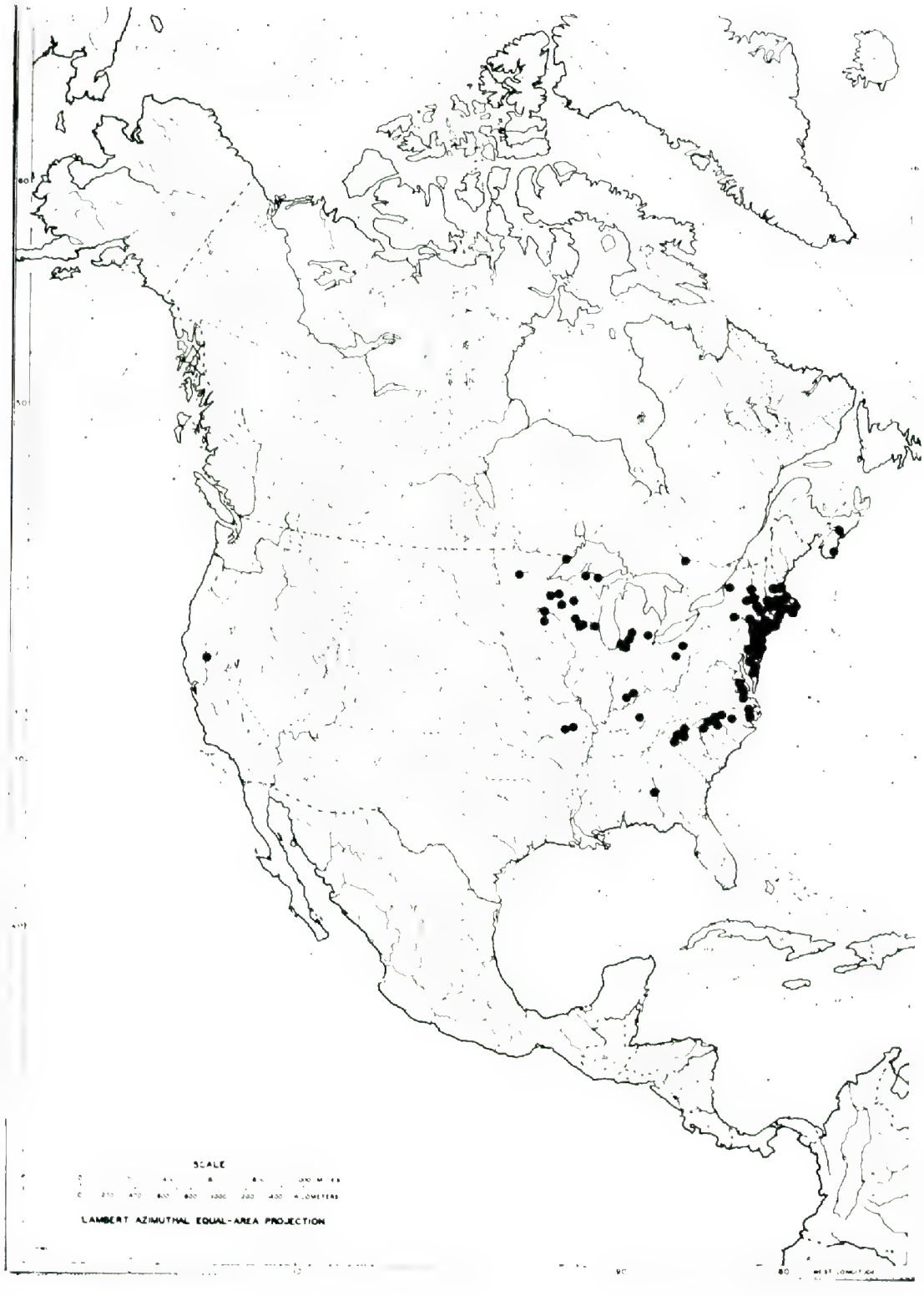


Fig. 6. Map of North America showing the documented distribution of *Najas gracillima*.

quite narrow leaves. However, *N. ancistrocarpa* is easily distinguished from the latter two species by its recurved fruits (sometimes crescent-shaped). I know of no other *Najas* with such curved fruits.

7. NAJAS MINOR Allioni, Fl. Pedemon. 2:221.1785.

Caulinia fragilis Willd., Mem. Acad. Roy. Sci. Hist. (Berlin) 94. 1798.
C. indica. Willd., Mem. Acad. Roy. Sci. Hist. (Berlin) 95. 1798.
C. minor (Allioni) Coss & Germ., Fl. Paris 575. 1845.
Fluvialis minor (Allinoi) Pers., Synops. 2:530. 1807.
Ittnera minor (Allioni) C. C. Gmel., Fl. Bad. 3:590. 1808.
Najas australis Bory ex Cham., Linnaea 4:501. 1829.
N. dichotoma Roxb., Hort. Beng. 71. 1814.
N. fragilis (Willd.) Rostk. & Schmidt, Fl. Sedin. 382. 1824.
N. indica (Willd.) Cham., Linnaea 4:501. 1829.
N. minor var. *setacea* A. Br., J. Bot. 2:278. 1864.
N. setacea (A. Br.) Rendle, Trans. Linn. Soc. London, Bot. 5:422. 1899.
N. subulata Thuill., Fl. Paris (ed. 2) 500. 1800.
N. ternata Roxb. ex. Gric., Notul. 3:183. 1851.

Plants monoecious. Stems 11–120 cm long, 0.2–1.0 mm in diameter, profusely branched near apex; internodes 0.5–5.8 cm long, without prickles. Leaves 0.5–3.4 cm long; laminae usually recurved with age, 0.1–1.2 mm wide, acute with 1–2 teeth at apex, conspicuously serrulate with 7–15 teeth per side, the terminal teeth similar in size and structure to the lateral teeth, the teeth multicellular, the midrib without prickles; sheaths 1.0–3.0 mm wide, wider than the laminae, truncate to auriculate, serrulate to lacerate with 5 to 8 teeth per side, the teeth similar in size and structure to those of the laminae. Flowers 1–2 per axil, the staminate in the upper axils, the carpellate throughout, the involucre light green to purple; staminate flowers 1.9–2.2 mm long, the involucre beaks 0.4–2.1 mm long, 2-lobed, the anther ca. 0.3 mm long, 1–loculed; carpellate flowers ca. 2.2 mm long, the styles 1.0–1.2 mm long, the stigmas 2–lobed. Seeds 1.5–3.0 mm long, 0.5–0.7 mm wide, purplish, slightly recurved, the testa pitted, the areolae 4–angled, ca. 0.01 mm long, ca. 0.03 mm wide in ca. 15 longitudinal rows, the end walls not raised (Fig. 8J). Chromosome number, $2n = 12$ (Sharma and Chatterjee 1967).

Ponds, lakes, and slow moving streams; New York to Illinois, south to Florida, Mississippi, and Arkansas (Fig. 7).

TYPE: ITALY: Pedemont (Holotype, TO, photo, UNA!).

Najas minor, native of the Eastern Hemisphere, apparently invaded North America nearly 50 years ago (Meriläinen 1968, Wentz and Stuckey 1971). With the gradual eutrophication of the waters of eastern United States, the species has become quite widespread and, in fact, has become the most abundant *Najas* in some areas (Wentz and Stuckey 1971).

Najas minor, with its mature leaves recurved and with its areolae broader than long and arranged in longitudinal rows like the rungs of a ladder, is one of the more distinctive species of *Najas*. However, young sterile indi-

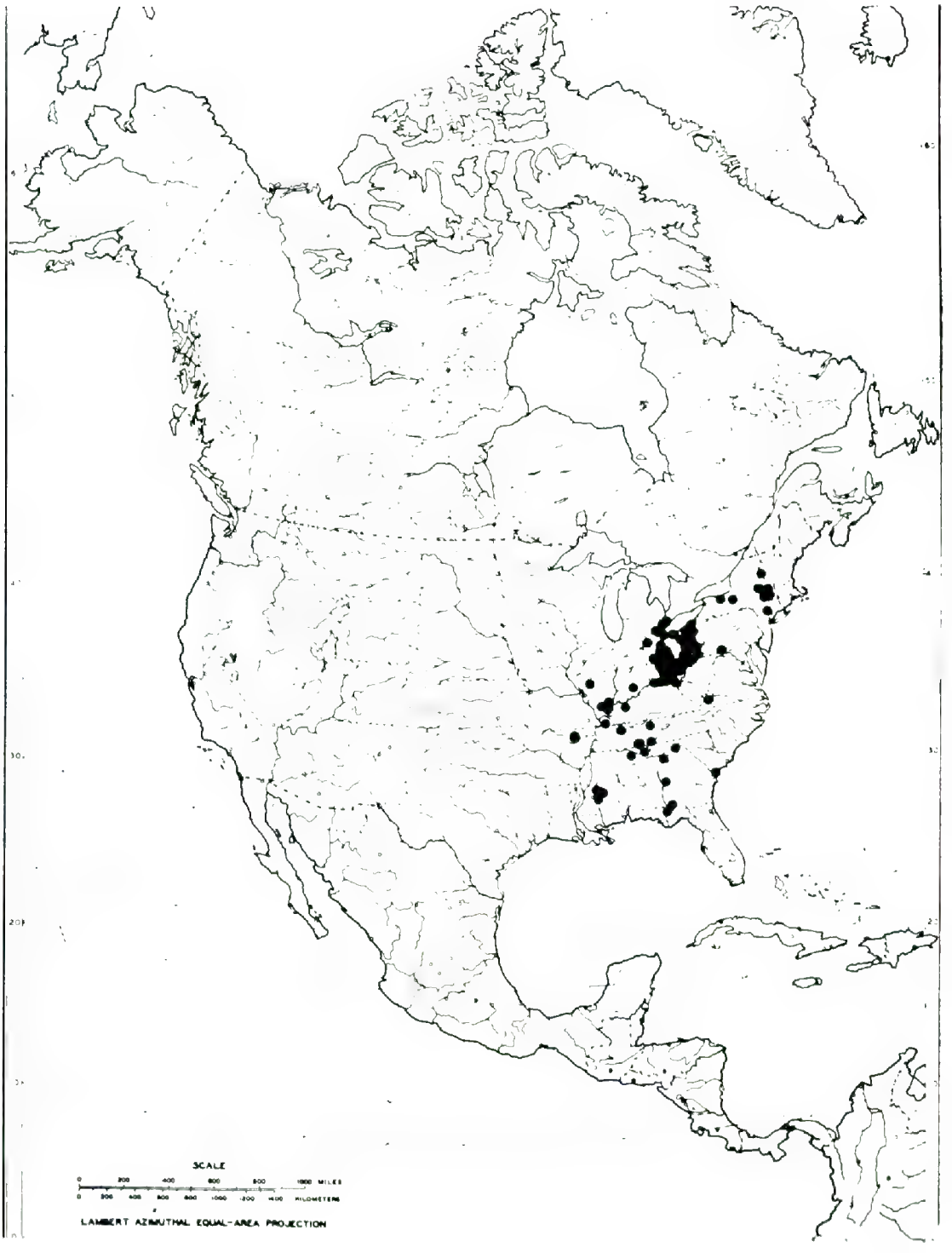
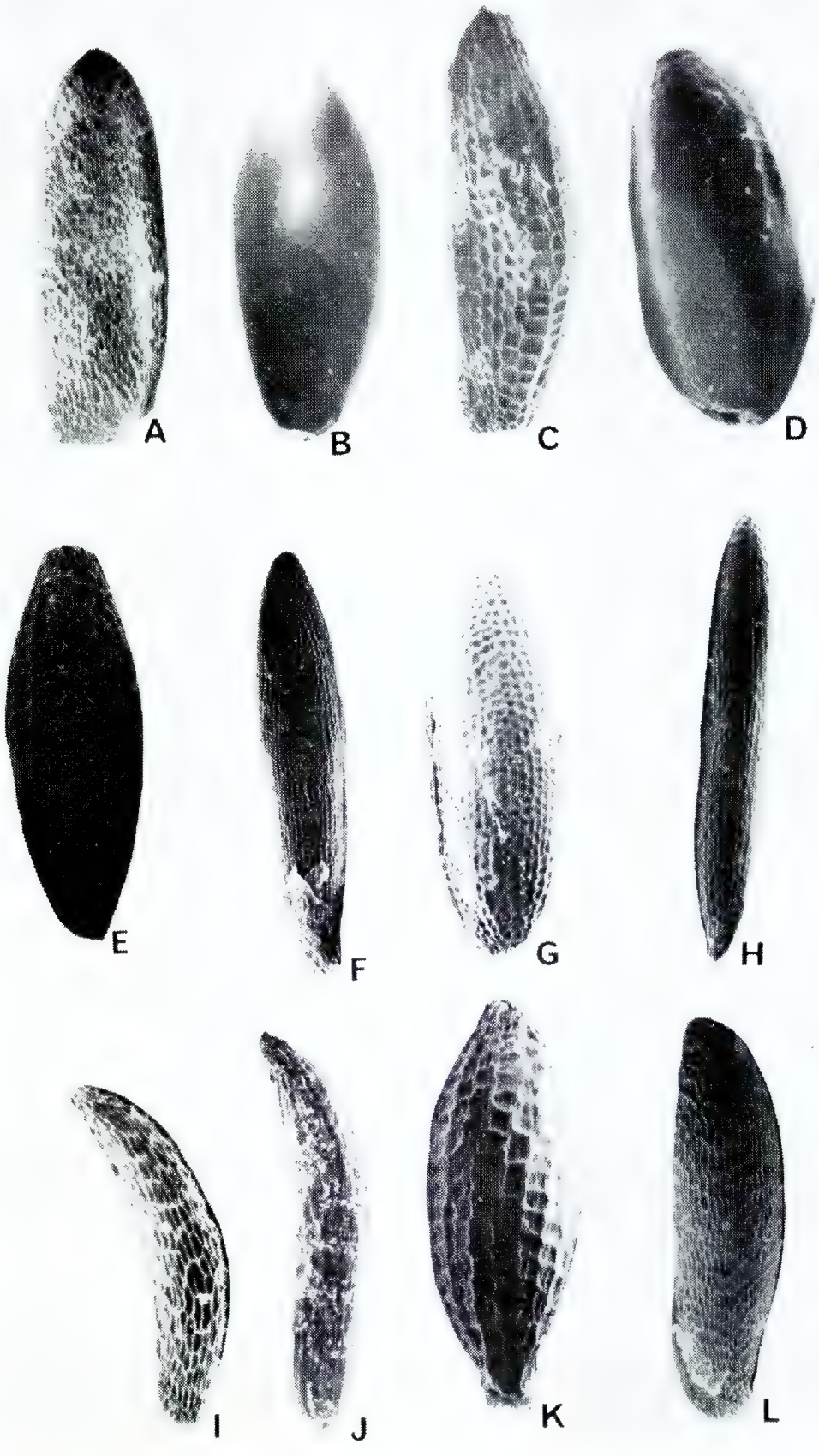


Fig. 7. Map of North America showing the documented distribution of *Najas minor*.

Fig. 8. *Najas* seeds. SEM micrographs taken at 20 KV. A. *N. marina* (X $9\frac{1}{2}$). B. *N. flexilis* (X 18). C. *N. guadalupensis* var. *guadalupensis* (X $28\frac{1}{4}$). D. *N. guadalupensis* var. *olivacea* (X $25\frac{1}{2}$). E. *N. guadalupensis* var. *floridana* (X $33\frac{1}{2}$). F. *N. guadalupensis* var. *muenscheri* (X 19). G. *N. graminea* (X $23\frac{3}{4}$). H. *N. gracillima* (X 19). I. *N. ancistrocarpa* (X $20\frac{1}{4}$). J. *N. minor* (X $19\frac{1}{4}$). K. *N. wrightiana* (X 43). L. *N. arguta* (X $18\frac{1}{2}$).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viduals resemble *N. gracillima*. Meriläinen (1968) indicated that *N. minor* can be separated from the latter species by the former having recurved leaves and the latter having leaves not recurved. Wentz and Stuckey (1971) demonstrated that the leaves of *N. minor* do not become recurved until late in the growing season. Therefore, during the early growing season, individuals of *N. minor* could be mistaken for *N. gracillima* when one utilizes vegetative characters only.

8. NAJAS WRIGHTIANA A. Br., Sitzber. Ges. Naturf. Fr. Berlin 17. 1868.

Najas multidentata Koch, Ber. Schweiz. Bot. Ges. 44:341. 1935.
N. wrightiana subsp. *multidentata* (Koch) Clausen, Bull. Torrey Bot. Club 73:365. 1946.

Plants monoecious. Stems 9–45 cm long, 0.3–1.0 mm in diameter, profusely branched; internodes 0.3–5.2 cm long, without prickles. Leaves 0.5–2.6 cm long; laminae ascending, 0.2–1.3 mm wide, acute with 1 tooth at apex, conspicuously serrulate with 8–22 teeth per side, the terminal tooth similar in size and structure to the lateral teeth, the teeth mulicellular, the midrib without prickles; sheaths 0.7–2.8 mm wide, wider than the laminae, round, serrulate with (1–) 3–5 teeth per side, the teeth similar in structure and size to those of the laminae. Flowers 1–2 per axil, the staminate in the upper axils, the carpellate in the lower axils, the involucre brown to red purple; staminate flowers 1.2–1.9 mm long, the involucre beaks 0.3–0.5 mm long, 2–lobed, the anther ca. 1.0 mm long, 4–loculed; carpellate flowers ca. 2.0 mm long, the styles to 0.7 mm long, the stigmas 4-lobed. Seeds 0.7–1.5 mm long, 0.3-0.5 mm wide, whitish, fusiform, the testa pitted, the areolae 5–angled, ca. 0.1 mm long, less than 0.1 wide, in ca. 20 longitudinal rows, the end walls raised (Fig. 8K). Chromosome number unknown.

Slow moving streams and ponds, Veracruz to Florida, south to Guatemala, Honduras, and Cuba (Fig. 5).

TYPE: CUBA (B, destroyed during World War II).

Najas wrightiana superficially resembles *N. arguta*. Clausen (1946) discussed this similarity and suggested that the two species could be separated by teeth of *N. wrightiana* being longer than the rest of the lamina is wide, whereas those of *N. arguta* are shorter than the rest of the lamina is wide. I believe, however, the best characters are those of the seed. The seeds of *N. wrightiana* are short (1.0–1.5 mm long) and have 5–angled areolae arranged in ca. 20 rows. *Najas arguta* seeds, on the other hand, are 2.1–2.6 mm long and have elongate areolae arranged in ca. 50 rows.

9. NAJAS ARGUTA H.B.K., Nov. Gen. et Sp. Pl. 1:371. 1815.

Caulinia tenella C. G. Nees in Neuwied, Reise Bras. 2:345. 1824.
Najas tenera Schrad., Gott. Gel. Anz. 2:715. 1825.

Plants monoecious. Stems 15–70 cm long, 0.3–1.0 mm in diameter, profusely branched; internodes 0.5–13.5 cm long, without prickles. Leaves 1.2–2.8

cm long; laminae spreading, 0.6–1.9 mm wide, acute to acuminate with 1 tooth at apex, conspicuously serrulate with 15–25 teeth per side, the terminal tooth slightly larger than but similar in structure to the lateral teeth, the teeth multicellular, the midrib without prickles; sheaths 1.2–3.4 mm wide, wider than the laminae, round to truncate, serrulate with 2–7 teeth per side, the teeth smaller than but similar in structure to those of the laminae. Flowers 1 per axil, the staminate in the upper axils, the carpellate in the lower axils, the involucre purple-tinged; staminate flowers 2.0–2.2 mm long, the involucre beaks ca. 0.5 mm long, 4–lobed, the anther to 1.6 mm long, 1–loculed; carpellate flowers 1.7–2.1 mm long, the styles ca. 0.5 mm long, the stigmas 3–4–lobed. Seeds 2.1–2.6 mm long, 0.6–0.8 mm wide, yellowish-white, elongate-fusiform, the testa pitted, the areolae sometimes inconspicuous, 5–6–angled, to 0.2 mm long, ca. 0.05 mm broad, in ca. 50 longitudinal rows, the end walls raised (Fig. 8L). Chromosome number unknown.

In lakes, Panama and the Dominican Republic (Fig. 5).

TYPE: Provenit in aquis prope momprox- Regno novogranatensi (P?).

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BASSIA (CHENOPODIACEAE) IN NORTH AMERICA

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ABSTRACT

A survey of literature and herbarium specimens indicates that two species of *Bassia* (Chenopodiaceae), both introduced, have become established members of the North American flora. *Bassia hirsuta* entered the flora of North America around 1900, and has gradually expanded its range along the East Coast. *Bassia hyssopifolia* has spread extensively in western North America since its introduction in Nevada around 1915, and has maintained a limited distribution in the East following its introduction there around 1930.

INTRODUCTION

The introduction of non-indigenous species into a geographic region may alter the structure and composition of local plant populations, in some cases presenting deleterious ecological consequences. The history of *Eichhornia crassipes*, water hyacinth, in North America clearly demonstrates this point. All too frequently botanists do not adequately document the spread and effect of adventive species (particularly their ability to compete with local species), even though such studies are usually feasible, interesting, and sometimes valuable. Many questions on immigrant species often remain unasked, not to mention unanswered, including: Where did the plant come from? When and how was it introduced? Where has it spread since its introduction, and by what mechanisms? What habitats does it invade? Has it become a permanent member of the flora? Will it probably continue to extend its non-intrinsic range?

In reference to the above questions, the genus *Bassia* (Chenopodiaceae) can be taken as an example. *Bassia*, a rather well-known and significant Eurasian genus of annual herbs, has about 10 species (ca. 90 species if the Australian *Austrobassia* is included in it); however, little is known (at least by any kind of comprehensive study) of its adventive distribution, particularly its North American occurrence. In addition to distributional questions, the genus presents nomenclatural difficulties. Several authors (cf. Iljin, 1936; Standley, 1916; Mason, 1957) used an alternate generic name, *Echinopsilon*, in preference to *Bassia*. To add to the confusion, some taxonomists employed the name *Bassia* for a genus of Sapotaceae (cf. Airy Shaw, 1973). Nomenclatural problems exist at the species level as well. Authorship of the combination *Bassia hyssopifolia*, for example, has been credited to Kuntze (cf.

SIDA 8(1): 57–64. 1979.

Gleason, 1952) or to Volkens (cf. Davis, 1952; Aellen, 1964). In our study, in addition to providing distributional information, we attempt to clarify the nomenclatural aspect.

NOMENCLATURE

The generic name *Bassia* was "originally" published on two separate occasions. Allioni in 1766 (Mélanges de Philosophie et de Mathématique de la Société Royale de Turin, p. 177) assigned the name to a genus in the Chenopodiaceae. Independently, Koenig proposed the name for inclusion in Sapotaceae, but did not publish it. Linnaeus subsequently validated Koenig's manuscript name by incorporating it in his *Mantissa* (*Mantissa Plantarum* 2; Appendix, p. 563; 1771). As both names are validly published under the rules of nomenclature, *Bassia* Koenig ex Linnaeus (Sapotaceae) must be regarded as illegitimate and to be rejected as a later homonym. *Bassia* Allioni is the correct name of the genus.

A commonly used synonym of *Bassia* Allioni is *Echinopsilon* Moquin-Tandon. However, publication of this name (Annales des Sciences Naturelles 2,2: 127, 1834) was much later than that of *Bassia* Allioni, and there would seem to be no reason for selecting it over *Bassia. Chenolea* Thunberg (*Nova Genera Plantarum* 10, 1781), which has likewise been preferred in some cases over *Bassia* (e.g., Bentham and Hooker, *Genera Plantarum* 3: 60, 1880), also has a later date of publication, and, in addition, probably constitutes a distinct genus (cf. Airy Shaw, 1973).

Credit for the combination *B. hyssopifolia* should go to Kuntze (*Revisio Generum Plantarum* 2: 547, 1891) rather than Volkens (in Engler and Prantl's *Die Natürlichen Pflanzenfamilien* 3,1a: 70, 1893) on the basis of priority. The correct citation is *B. hyssopifolia* (Pallas) Kuntze, based on *Suaeda hyssopifolia* Pallas.

DISTRIBUTION

Only two species of *Bassia, B. hirsuta* and *B. hyssopifolia*, have been recorded in North America. Though introduced, both species are well-established, permanent members of the flora. The distribution of each is discussed separately below. Discussions are based in part on specimens from the following herbaria: A, F, GH, JEPS, MO, MU, NY, OSC, PH, RM, TEX, UC, US, and UT. We are grateful to the curators of these herbaria for the loan of specimens.

The two species of *Bassia* occurring in North America may be distinguished as follows:

Bassia hirsuta: Floriferous portion of branches with flexuous axis; three sepals bearing a short, non-hooked, dorsal process in fruit, the other two sepals unappendaged.
Bassia hyssopifolia: Floriferous axis straight; all five sepals bearing a slender, hooked prickle in fruit.

Bassia hirsuta

Bassia hirsuta (L.) Ascherson, the first *Bassia* species to appear in North America, maintains today a limited though well-established distribution along the east coast of the United States. Native to Europe (type locality: along the seacoast of Montpellier, France), *B. hirsuta* apparently entered our flora around the turn of the century. Earliest specimens are from southern New Jersey (Anglesea, Cape May County, 30 Aug 1900, *Brown s.n.*, PH; Barnegat Bay Beach, Ocean County, 21 Jul 1900, *Harshberger s.n.*, PH). However, early floristic studies (e.g., Robinson & Fernald, 1908; Britton & Brown, 1913) neglected this species. In fact, we find no mention of the plant in literature until Taylor (1915) alluded to its presence along the borders of salt marshes around New York City. By this time, its distribution, according to herbarium records, reached from Massachusetts to New Jersey. Initial spread was apparently rapid, as it was recorded in South Boston by 1908 (12 Sep 1908, *Knowlton s.n.*, GH). Knowlton commented (on the specimen label) on the abundance of *B. hirsuta* on "made land, in tidal brook and elsewhere." Standley (1916) wrote "adventive on sandy seashores, New Jersey, and at Boston, Massachusetts," indicating a possible disjunct distribution. As indicated above, however, the plant was already present in New York State by the time of Standley's writing. In fact, a specimen (*Bicknell 3968*, PH) was collected from Long Island in September 1915, and it is likely that *B. hirsuta* actually invaded the New York flora several years prior to this.

According to more recent floristic literature (e.g., Fernald, 1950; Gleason, 1952), the distribution extends from Massachusetts to Maryland, in coastal sandy or saline habitats. Herbarium records confirm this habitat statement but indicate a range south to Virginia (Chincoteague Is., 23 Jul 1938, *Travis 679*, PH). Delaware is the only state between Massachusetts and Virginia from which *B. hirsuta* has apparently not been recorded either by literature or herbarium specimens. However, it is not likely that disjunction is actually involved. A careful search would probably show a limited occurrence of the species within the state's coastal islands.

As to the future of *B. hirsuta* in North America, a limited increase in range with time is probable, confined primarily to saline coastal areas. This statement is based on the documented gradual increase (since its original rapid spread) up to the present, the availability of additional coastal area for colonization (particularly south), and the local success of populations as suggested by information on herbarium specimen labels. Several collectors indicated that *B. hirsuta* was densely established on various beaches (e.g., *Knowlton s.n.*, South Boston, 4-18 Sep 1909, UC). Fernald (1950) stated that the plant "appears indigenous," an indication of its success in naturalization and its potential for persistence.

The method of entry and spread is uncertain; thus, we are limited to speculation. Considering the plant's lack of economic value and its relative

unsightliness, it was in all probability not imported purposefully. The immigration of *B. hirsuta* to this continent must be considered accidental and mose likely due to man. As its early distribution (around 1908) in North America was possibly disjunct (Massachusetts and southern New Jersey), it is not improbable that the species was introduced from Europe more than once. After it initial introduction and establishment, shore animals (especially birds) and tidal activity certainly contributed to a gradual range expansion.

Representative Specimens (one specimen from each county recorded in our study is included): UNITED STATES: MARYLAND: Worcester Co.: brackish flat bordering Assawomen Bay, Ocean City, 16 Sep 1941, *Herman 10769* (MO, NY, US). MASSACHUSETTS: Barnstable Co.: Monument Beach, Bourne, 18 Aug 1921, *Blake 8363* (TEX); Dukes Co.: Penikese Island, 31 Jul 1947, *Moul and Moul 3247* (PH); Norfolk Co.: Wollaston, 21 Sep 1918, *Blake 7195* (US); Suffolk Co.: South Boston, 12 Sep 1908, *Knowlton s.n.* (GH). NEW JERSEY: Atlantic Co.: Atlantic City, 25 Sep 1906, *Wheeler s.n.* (US); Camden Co.: Cooper's Point R.R. Freight Yard, Camden, 19 Aug 1932, *Witte s.n.* (PH); Cape May Co.: Anglesea, 30 Aug 1900, *Brown s.n.* (PH); Cumberland Co.: Delaware Bay, Moore's Beach, Robinson's Beach, s. of Delmont, 22 Jun 1933, *Long 40685* (PH); Essex Co.: Port Newark, 23 Sep 1933, *Edwards and Clausen 497* (NY); Ocean Co.: Barnegat Bay Beach, 21 Jul 1900, *Harshberger s.n.* (PH). NEW YORK: Nassau Co.: Long Beach, East Point, Long Island, 19 Sep 1915, *Bicknell 3968* (PH); Suffolk Co.: Point-O-Woods, Long Island, 9 Sep 1921, *Ferguson 879* (NY); Queens Co.: Jamaica Bay Sanctuary, Queens, Long Island, 7 Sep 1958, *Monachino 629* (NY). VIRGINIA: Accomack Co.: Chincoteague Island, 23 Jul 1938, *Travis 679* (PH).

Bassia hyssopifolia

Bassia hyssopifolia (Pallas) Kuntze apparently entered the flora of North America 15 to 20 years later than *B. hirsuta*. Like *B. hirsuta, B. hyssopifolia* must be regarded as introduced in North America; it is native to parts of Europe and Asia (type locality: Caspian Sea region). Unlike *B. hirsuta, B. hyssopifolia* appeared first in western North America. The earliest reference we found to *B. hyssopifolia* in America (Blake, 1922) cites Fallon (Churchill County), Nevada (28 Jul 1919, *Tidestrom 10755*, US) as the site of earliest collection. A search of early floristic literature (e.g. Jepson, 1923; Rydberg, 1906, 1917; Standley, 1916) yielded no mention of *B. hyssopifolia*. It is included, however, for Nevada by Tidestrom (1925) and in more recent western floras (e.g., Harrington, 1954; Kearney & Peebles, 1960; Munz & Keck, 1959; Hitchcock & Cronquist, 1973; Weber, 1972). In general, the plant is said to be well-established, especially in saline or alkaline habitats varying in altitude from below sea level to several thousand feet.

The earliest North American specimen in a herbarium is that of T. H. Kearney (US), 1917, from Fallon, Nevada—a collection apparently unknown to Blake. As the plant was probably present a year or so prior to collection, 1915 would be reasonable as to the approximate time of introduction. After establishment in Nevada, *B. hyssopifolia* spread rapidly in all directions.

Based on herbarium records, the following would be the sequence of establishment: California, 1919; Washington, 1921; Utah, 1924; New Mexico, 1926; Montana, 1927; Texas, 1928; Oregon. 1932; Arizona, 1936; Colorado, 1936; Idaho, 1937; British Columbia, 1937; Wyoming, 1939; and South Dakota, 1959. It is probable that *B. hyssopifolia* entered Oregon considerably earlier than records show, thus providing access to Washington, Idaho, and Canada. According to Moss (1959), this species has been found in Alberta.

The means of introduction and dispersal of *B. hyssopifolia* seems relatively clear. As the earliest plants were discovered in rangeland near the Fallon experimental Station in Nevada, it is conceivable that propagules entered originally from Eurasia as a seed contaminant. *Bassia hyssopifolia* grows well in soil too alkaline for crops (Blake, 1922) and thus finds a suitable niche in impoverished abandoned fields. The sepals persist around the ripened fruit, and each bears on its back a hooked spine (hence the common name "five-hook bassia"). These small hooks attach the one-seeded fruits readily to clothing, livestock, or wildlife, providing an effective dispersal mechanism. Establishment in dry, alkaline or saline environments where competition is minimal would seem to aid survival and necessitate regarding *B. hyssopifolia* as a permanent, and sometimes "weedy," member of the North American flora. As stated by Munz and Keck (1959), *B. hyssopifolia* is "becoming a common weed in rather alkaline places through much of Calif. and in other w. states."

Some 15 years after its introduction in western North America, *B. hyssopifolia* appeared in coastal eastern North America. The earliest herbarium specimens from the east are dated 1936 (Massachusetts, 5 Sep 1936, *Bean s.n.*, GH; and New York, 3 Sep 1936, *Monachino 161*, NY). However, literature (Palmer, 1930; Bean, 1937) points to an earlier arrival. Palmer (1930) documented the spontaneous growth of *B. hyssopifolia* in an abandoned quarry near the Arnold Arboretum in the Boston area. Later (1936), Bean discovered the plant near Fish Pier and the freight yard area of South Boston and also alluded to its occurrence several years earlier near Worcester, Massachusetts. Based on the evidence, 1929-1930 is the probable time of introduction of *B. hyssopifolia* in the east. There are no firm facts by which to confirm whether this appearance in the eastern United States constituted a second introduction from Eurasia or a transmittal from the western United States. Bean reported the Fish Pier locality as a vacant lot where wool-waste was thrown out and hinted at an introduction from southwestern Asia. However, this information provides an insufficient basis for making final judgment as to the source of the introduction. Regardless, *B. hyssopifolia* has maintained a limited distribution on the east coast. Seymour (1969) contended that the plant is rare in Massachusetts, being found in only four locations: Chelmsford, South Boston, Westford, and Worcester. The two New York counties in which it grows are both on the western end of Long Island. Thus, it seems safe to assume that *B. hyssopifolia* occurs in scattered

locations from Boston to New York City and that it will remain in the eastern flora, perhaps not extending its range to any appreciable extent.

Representative Specimens (one specimen from each county recorded in our study is cited): CANADA: BRITISH COLUMBIA: Cariboo Co.: Three Mile Lake, S of Clinton, 12 Aug 1956, *Calder, Parmalee and Taylor 20061* (GH, NY); Prince Rupert Co.: 1 mi E of Inverness, 11 Aug 1958, *Taylor and Ferguson 3752* (UC); Yale Co.: near alkaline lakes below Sugarloaf Hills, Kamloops, 17 Oct 1965, *Krajina 65101713* (NY).

UNITED STATES: ARIZONA: Maricopa Co.: Arlington, 12 Aug 1936, *McLellan and Stitt 1009* (US); Navajo Co.: Kayenta, 11 Sep 1938, *Eastwood and Howell 6541* (US). CALIFORNIA: Alameda Co.: Newark, 21 Oct 1966, *O'Brien s.n.* (UC); Colusa Co.: Maxwell, 1 Oct 1929, *Jepson 15341* (UC); Fresno Co.: 1 mi W, 2 mi S of Fresno, 23 Oct 1919, *Hall s.n.* (UC, US); Glenn Co.: S of Willows, 17 Jun 1934, *Howell 12247* (GH); Imperial Co.: between Brawley and Imperial, 17 Oct 1941, *MacBride and Drouet 4515* (F, UC); Inyo Co.: Independence, 4 Aug 1940, *Kerr s.n.* (TEX); Kern Co.: Bakersfield, 13 Nov 1926, *Bauer s.n.* (UC); Lassen Co.: Honey Lake Valley near Wendel, 12 Jul 1934, *Howell 12568* (F); Los Angeles Co.: Long Beach, 12 Nov 1928, *Bauer s.n.* (UC, US); Merced Co.: 1 mi NW of Los Banos, 27 Sep 1921, *Kennedy s.n.* (UC); Modoc Co.: Alturas, 10 Oct 1935, *Wheeler 4035* (GH, NY, US); Mono Co.: 4 mi SE of Fales Hot Springs, 9 Sep 1934, *Crum 1712* (UC); Orange Co.: West Newport Beach, 27 May 1932, *Booth 1130* (UC); San Benito Co.: Silver Creek, 4 Oct 1966, *Twisselmann 12877* (OSC); San Bernardino Co.: Searles Lake at Trona, 20 Oct 1964, *Twisselmann 10310* (OSC); San Diego Co.: San Diego, 18 Jul 1934, *Youngberg s.n.* (UC); San Francisco Co.: S of Hunter's Point, San Francisco, 3 Jun 1956; *Howell 31466* (OSC); San Mateo Co.: E of Redwood City, 27 Aug 1949, *Nobs and Smith 1617* (UC); Santa Clara Co.: Palo Alto Yacht Harbor, 12 Sep 1932, *Ferris 8267* (UC); Siskiyou Co.: Shasta Valley 4 mi E of Grenada, 21 Oct 1934, *Wheeler 3332* (F); Solano Co.: Suisun City, 9 Oct 1932, *Booth 2071* (F); Stanislaus Co.: W side of Modesto, 1 Oct 1928, *Dudley s.n.* (F); Tulare Co.: T23S, R24E, Sec 30, 2 mi SE of Stoil, 29 May 1940, *Bradshaw 333* (TEX); Ventura Co.: Ocean beach near mouth of Ventura River, 29 Sep 1945, *Pollard s.n.* (UC). COLORADO: Alamosa Co.: Alamosa, 2 Sep 1936, *Ramaley 15908* (RM); Bent Co.: Prowers, 3 Sep 1940, *Cory s.n.* (GH); Boulder Co.: just E of Boulder Reservoir, 19 Sep 1965, *Weber 12972* (TEX, NY, UT); Eagle Co.: Wolcott, 17 Sep 1960, *Perdue 4062* (US); Montezuma Co.: Cortez, 29 Aug 1947, *Durham s.n.* (F). IDAHO: Ada Co.: 4 mi N of Grandview, 19 Jun 1940, *Davis 2063* (F, NY, UC); Bingham Co.: Springfield, 4 Sep 1937, *Christ 8946* (NY); Cassia Co.: mouth of Raft River, 24 Aug 1940, *Christ 11803* (NY); Custer Co.: 1 mi NW of May, 20 Aug 1944, *Hitchcock and Muhlick 11304* (NY); Franklin Co.: ca. 15 mi NNW of Preston, 6 Sep 1961, *Bright 61-73* (RM); Gem Co.: 12 mi W of Emmett, 6 Aug 1937, *Christ 8526* (NY); Lemhi Co.: 4 mi S of Tendoy, 18 Aug 1956, *Baker 14642* (NY); Owyhee Co.: Homedale, 18 Aug 1928, *Haegete s.n.* (NY); Power Co.: 5 mi W of Pocatello, 12 Jul 1937, *Christ 8364* (NY); Twin Falls Co.: 2 mi E of Buhl, 14 Jul 1937, *Christ and Ward 8179* (NY); Washington Co.: 5 mi S of Weiser, 25 Jul 1940, *Davis 3003* (F). MASSACHUSETTS: Suffolk Co.: wasteland, South Boston, 5 Sep 1936, *Bean s.n.* (GH). MONTANA: Phillips Co.: National Wildlife Refuge, Bowdoin, 26 Sep 1940, *Hotchkiss s.n.* (US); Sanders Co.: Perma, 17 Sep 1927, *Kirkwood 2497* (GH, RM). NEVADA: Churchill Co.: Fallon, 18 Aug 1917, *Kearney s.n.* (US); Clark Co.: across from hospital, Boulder, 8 Jun 1967, *Mears 1942* (TEX); Elko Co.: 7 mi N of Currie, 10 Sep 1937, *Train 969* (F, MO, UC); Humboldt Co.: Ashdown Mine, Pine Forrest Range, 22 Sep 1934, *Train 189* (US); Lander Co.: 10 mi W of Austin, 30 Aug 1937, *Goodner and*

Henning 1294 (F, MO); Lyon Co.: T12N, R23E, Sec 36, Wellington, 20 Sep 1937, *Johannsen 1279* (UC); Mineral Co.: S end of Walker Lake, 6 Sep 1938, *Archer 6963* (UT); Nye Co.: Golden Eagle Mill NW of Ione, 20 Aug 1940, *Beach 1031* (UC); Storey Co.: 4 mi E of Virginia City, 10 Sep 1937, *Allen 524* (UC); Washoe Co.: Pyramid Lake, 7 Sep 1930, *Abrams 12917* (F, GH, UC); White Pine Co.: T15N, R68E, Sec 19, 13 Aug 1964, *Holmgren and Reveal 1642* (GH, NY). NEW MEXICO: Doña Ana Co.: Mesquite, Mesilla Valley, 7 Aug 1930, *Fosberg 53831* (UC); Sandoval Co.: Bernalillo, 11 Jul 1926, *Arsène and Benedict 16799* (F, US). NEW YORK: Bronx Co.: Pelham Bay Park, N.Y. City, 10 Oct 1954, *Monachino 551* (NY); Queens Co.: Newton Creek, Queens, Long Island, 3 Sep 1936, *Monachino 161* (US). OREGON: Gilliam Co.: Olex, 15 Oct 1938, *Cooke 12112* (OSC); Grant Co.: Canyon City, 31 May 1951, *Farrell s.n.* (OSC); Harney Co.: Malheur Lake, 30 mi S of Burns, 13 Aug 1957, *Hansen s.n.* (OSC); Lake Co.: 1932, *Hill s.n.* (OSC); Malheur Co.: Ontario, 7 Sep 1928, *Larsen s.n.* (GH, OSC); Morrow Co.: Irragon, 1 Aug 1933, *Peck 18100* (OSC); Sherman Co.: 29 Sep 1955, *Thompson s.n.* (OSC); Umatilla Co.: Hermiston, Nov 1932, *Best s.n.* (OSC); Union Co.: North Powder, 15 Aug 1958, *Sidor s.n.* (OSC); Wheeler Co.: 3 mi W of Mitchell, 20 Jul 1934, *Peck 18641* (OSC). SOUTH DAKOTA: Jones Co.: 1 mi S of Murdo, 28 Aug 1959, *Wiggins 14974* (US). TEXAS: El Paso Co.: N of El Paso, Sep 1938, *Kelly s.n.* (GH); Hudspeth Co.: Trans Pecos, 2 mi SE of McNary, 18 Aug 1942, *Waterfall 3971* (GH); Reeves Co.: Pecos, 4 Sep 1939, *Cory 32958* (GH); Ward Co.: Barstow, 20 Jul 1928, *Cory 1454* (GH). UTAH: Box Elder Co.: Sulphur Springs, 15 Aug 1929, *Garrett 5423* (UT); Carbon Co.: 10 mi E of Wellington, 7 Aug 1940, *van Cott 78* (NY); Davis Co.: Farmington Bay Waterfoul Management Area, 8 Jul 1966, *Arnell s.n.* (UT); Duchesne Co.: waste places, 2 Sep 1938, *Harrison and Garrett 8886* (UC); Salt Lake Co.: saline flats, 26 Sep 1924, *Garrett 3190* (US, UT); Sanpete Co.: Ephraim, 15 Sep 1934, *Olsen s.n.* (UC); Sevier Co.: SW corner of airfield S of Richfield, 16 Sep 1944, *Holmgren and Evans 3822* (GH, NY, UC); Tooele Co.: W of Garfield, 6 Aug 1929, *Garrett 5325* (UT); Uintah Co.: Thorne's Ranch, Willow Creek, 5 Aug 1935, *Graham 9983* (F); Utah Co.: Utah Lake, Provo, 6 Oct 1935, *Larson 6678* (US); Washington Co.: T43S, R16W, Sec 13, between fields and Virgin River at Bloomington, 9 Aug 1963, *Christian 1112* (UT); Wayne Co.: Henry Mountains, 15 Aug 1966, *Everitt 211* (UT); Weber Co.: Ogden Bay, 29 Jul 1955, *McHugh s.n.* (NY). WASHINGTON: Grant Co.: S end of Soap Lake, 15 Aug 1943, *Eyerdam 6389* (UC); Okanogan Co.: between Omak and Okanogan, 15 Sep 1933, *Fiker 1426* (US); Whitman Co.: Pullman, 23 Sep 1925, *Pickett s.n.* (GH, US); Yakima Co.: Yakima, 3 Oct 1921, *Nelson 1002* (US). WYOMING: Albany Co.: Laramie, 31 Aug 1939, *Meunscher and Meunscher 15931* (GH); Sweetwater Co.: Flaming Gorge Reservoir at Firehole, 20 Aug 1968, *Porter and Porter 10599* (RM); Washakie Co.: W of Worland, 31 Jul 1962, *Nichols 516* (RM).

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A NEW SPECIES OF *ERIGERON* (COMPOSITAE) FROM COAHUILA

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ERIGERON **chiangii** Nesom, sp. nov. (Fig. 1)

Ab affini *E. folioso* Nutt. acheniis discique flosculis brevioribus, pappi setis minus numerosis, foliisque basalibus spatulato-obovatis margine integris dentatisve incrassatis vel revolutis diversa.

Perennial herbs from a few, slender, woody roots, with a cluster of basal leaves and a single erect stem borne at the ends of short (1–4 cm), ascending, leafless, more or less woody, caudex branches, basal leaves usually deciduous by mid-summer. Erect stems 11–40 cm high, often reddish at the base, simple or usually with 1 to numerous branches, mostly branching from the upper 1/2 of the stem; at least the upper part of the stem (sometimes only under the heads) conspicuously and densely stipitate-glandular with dark orange-tipped, capitate, Type C trichomes,[1] otherwise completely glabrous if not glandular, rarely with tiny, viscid-appearing Type B trichomes and a very few, spreading Type A trichomes. Basal leaves hirsute or rarely pilose with fine Type A trichomes, pubescence of margins not different from that of the lamina, except longer at base of the petioles; lower cauline leaves moderately strigose-hirsute, eglandular, losing Type A trichomes and usually becoming densely stipitate-glandular higher on the stem, basal leaves spatulate to obovate or oblanceolate, subcoriaceous, margins slightly thickened or revolute, entire or with 1 or 2 pairs of pinnate teeth or lobes, apex rounded or barely mucronulate, usually about 3 cm long and 7 mm wide but up to 7.5 cm long and 14 mm wide, petiole when present about 1/3–1/2 as long as the leaf; cauline leaves numerous, alternate, sessile, markely different in shape from the basal leaves or sometimes changing gradually on the lower 1/3 of the stem, usually narrowly linear but sometimes oblong-oblanceolate, 7–55 mm long, 0.7–4.0 (6.0) mm wide, apex acute to rounded-mucronulate, entire, sometimes with reduced axillary clusters of smaller linear leaves.

[1] Illustrations of trichomes referred to as Types A, B, and C can be found in earlier studies of *Erigeron* (Nesom, 1976, 1978.).

SIDA 8(1): 65–70. 1979.

Heads at ends of erect stems or branches, not clustered, or stipitate-glandular penduncles 1–4 cm long; involucres narrowly companulate-hemispheric, about 6–12 mm wide, composed of 30–46 imbricated phyllaries in about 3 series, reflexing sharply after maturation and release of achenes; phyllaries lanceolate or oblanceolate, long acuminate, up to 0.8 mm wide, the innermost up to 6 mm long, the outermost about half as long, brownish-green with stramineous margins, sometimes purplish on the upper half, the innermost with narrow midribs and chartaceous margins, densely glandular with long Type C trichomes, without other vestiture; receptacles 1.5–3.0 mm wide, very shallowly convex, slightly tuberculate with raised carpopodial attachments points. Ray flowers, pistillate, fertile, 16–40 (50) in number, in 1–2 series, corollas mostly white, without a definite midstripe but often tinged with lavender, pink, or blue, 3–4 (5) veined, apex rounded, acute, or slightly notched, 5.0–9.5 mm long, remaining straight with wilting or age, the tubular portion about 1/3 of the total length, sparsely pubescent with long Type C trichomes, 0.9–1.5 mm long. Disc flowers perfect, fertile, about 30–100 in number, corollas yellowish, tubular to narrowly funnelform, glabrous or sparsely pubescent with Type C trichomes, sometimes slightly constricted in the lower 1/3, slightly indurated in the midregion, 2.6–4.0 mm high, 0.5–0.8 wide, the lobes 0.4–0.6 mm long and sometimes purple; anthers with thecae 1.2–1.5 mm long, with lanceolate apical appendages 0.2–0.3 mm long; style with branches 0.6–0.8 mm long, including the triangular to deltate collecting appendanges 0.17–0.26 mm long. Achenes oblong, laterally compressed, 1.3–1.8 mm long, 0.3–0.5 mm wide, tan, with 2 thin, orangish ribs, sparsely strigose with duplex trichomes; carpopodium a narrow, cartilaginous ring; pappus of ray and disc achenes similar, simple, of 16–20 tawny, barbellate bristles, equalling or slightly shorter than the height of the disc corollas, sometimes with a few short, outer setae or bristles. Chromosome number known from one collection (*Powell, Patterson, and Ittner 1602*) n=18.

TYPE: MEXICO. COAHUILA: Cañón de la Madera, Sierra de la Madera, 29 Mar 1975, *Wendt and Lott 842* (HOLOTYPE:LL!).

ADDITIONAL COLLECTIONS EXAMINED: MEXICO. COAHUILA: Mina El Popo, ca. 2 km S of Cañón El Diablo on dissected E slope of Sierra del Carmen, 29 Jul 1973, *Johnston, Chiang, Wendt and Riskind 11922* (LL); higher elevations in the Sierra Jardín (in the Sierra del Carmen), 1 Sep 1966, *Flyr 1210* (SMU); canyon descending E from high pass N of Sierra Jardín, 6 mi E of Rancho El Jardín, 23 May 1968, *Powell, Patterson, and Ittner 1602*—voucher for chromosome count of n=18 (TEX); middle and upper reaches of Cañón de la Hacienda, Sierra de la Madera, 10 May 1973, *Johnston, Wendt, and Chiang 10956* (LL); ibid., 6 Aug

Fig. 1. *Erigeron chiangii* Nesom, ca. 0.5X.

1973, *Henrickson 12000* with Wendt (LL- 2 sheets); ibid., 5 Aug 1973, *Henrickson 11950* with Wendt (LL); ibid., 21 Sep 1973, *Chiang, Wendt, and Johnston 9451E* (LL); higher part and N slope of Sierra de la Madera, SE and SSE of Rancho Cerro de la Madera, 20 Sep 1972, *Chiang, Wendt, and Johnston 9430A* (LL); about 10 km SW of R. San Miguel at Ejido Santa Eulalia in Cañón de los Burros, NE side of Serranías del Burro, 750 m alt., 2 Jun 1972, *Chiang, Wendt, and Johnston 7519C* (LL); along small, rocky canyon, about 1 mi N of "La Laguna," Cañón del Mulato, Serranías del Burro, alt. ca. 3500 ft, 8 Sep 1963, *Gould 10596* (TAES); Rancho Agua Dulce, E slope of the Sierra de San Manuel, 30 Jun 1936, *Wynd and Mueller 387* (MO, ARIZ, US, GH); Cañón de la Gavia, S of Rancho de la Gavia (Sierra de la Gavia), 2–3 Aug 1973, *Johnston, Wendt, Chiang, and Riskind 12035B* (LL); Mina El Aguirreno, N side of Sierra de la Paila, 5 Jul 1973, *Johnston, Wendt, and Chiang 11700* (LL); Canon El Cono, Sierra de la Gloria, 6 Sep 1976, *Wendt and Riskind 1621* (LL); Cañón de Milagro, E side of the Sierra de los Guajes, about 12 km W of Hacienda de la Encantada, 10 Sep 1941, *Stewart 1513* (GH); Sierra de San Marcos, opposite Los Fresnos, NE-facing slope, 4–5 Apr 1969, *Keil, Meyer, Lewis and Pinkava P6071* (ASU—several branches of *E. chiangii*, 1 plant and a branch of *E. sp.*); Sierra de San Marcos, opposite Los Fresnos, NE-facing slope, 4–5 Apr 1969, *Keil, Meyer, Lewis, and Pinkava 6120* (NY –1 plant of *E. chiangii*, 3 plants of *E. sp.*).

Dr. B. L. Turner first recognized that these plants deserved specific distinction and suggested the epithet. This commemorates Fernando Chiang, a recent graduate student at the University of Texas who was part of the group, with Dr. Marshall C. Johnston, which made several of the first collections of this taxon during their reconnaissance of the Chihuahuan Desert region. *Erigeron chiangii* is endemic to mountains and canyons of east-central Coahuila within a radius about 120 kilometers of Monclova. Most commonly it has been collected in calcareous gravel or limestone cliff crevices at about 750–2500 meters elevation. It grows in chaparral, izotal, or on limestone outcrops in oak-pine-fir forests at about 2700 meters.

The new species is very distinctive and easily recognized by the following characters: in most plants, a growth habit of clusters of hirsute, basal leaves at the ends of slender, leafless, ascending, caudex branches; basal leaves subcoriaceous with slightly thickened or revolute margins; cauline leaves mostly linear; 3 series of imbricate phyllaries; conspicuous, stipitate, orange-tipped glands on otherwise glabrous phyllaries and upper stems and leaves; relatively few, broad, white to bluish or pinkish ligules; and an essentially simple pappus of 16–20 bristles. The holotype (*Wendt & Lott 842*, from the Sierra de la Madera, Fig. 1) was chosen because it shows with relative completeness the nature of the roots, ascending caudex branches, basal leaves, and erect stems. Most of the plants of *Erigeron chiangii* on other sheets examined are broken off from the root system with only a portion of the caudex, and on other sheets collected later in the season, the basal leaves have been lost. The cauline leaves on the illustrated plant are more or less intermediate in shape for the species—leaves from other collections are either more narrowly linear or more broadly oblanceolate. All but one of the extremely linear-leaved collections of *E. chiangii* are from northwest

of Muzquiz in the Sierra del Carmen and Serranías del Burro. In that area the plants grow at elevations between the low and high extremes for the species. The single chromosome count for *E. chiangii* is tetraploid (n=18 from the Sierra del Carmen; Powell and Powell, 1978), and checks of pollen size and stainability suggest that plants over its whole range are probably also tetraploid.

Plants of *Erigeron chiangii* from the two collections cited from the Sierra de San Marcos (*Keil, Meyer, Lewis, & Pinkava 6071* and *6120*) are slightly atypical. The lower stems and leaves have moderately dense, spreading or retrorse pubescence in contrast to the normal glabrous condition. These plants are mounted on the same sheets with another species of *Erigeron*, yet unnamed, which is similar in general appearance to *E. chiangii*, at least at this locality. Other sheets from the same location have only plants of the other species. It seems likely that some gene flow is occurring between these taxa in the Sierra de San Marcos, but the plants of *E. chiangii* show little other evidence of hybridization. In characters of pappus, ligule width and coloration, glandularity, involucral pubescence and imbrication, and leaf texture and margin, they are typical.

Although limited hybridization may be occurring between plants of *Erigeron chiangii* and the unnamed taxon mentioned above, the closest relatives of *E. chiangii* appear to be in the *Erigeron foliosus-breweri* complex of California, Oregon, and Washington. At least some plants of this complex are strikingly similar in growth habit to *E. chiangii*, as well as in their linear to narrowly lanceolate or oblanceolate, often crowded, cauline leaves, their few ray flowers with broad ligules, and their strongly imbricated phyllaries. All of these taxa grow in dry, rocky habitats. The pubescence and glandularity characteristic of *E. chiangii* may also be found in plants of *E. foliosus* Nuttall, particularly in var. *confinis* (Howell) Jepson and in var. *hartwegii* (Greene) Jepson, but no single plant of these taxa has been observed in which the whole combination of *E. chiangii* characters occurs. According to Cronquist (1947) polymorphy and intergradation make taxonomic segregation among members of the *E. folisosus-breweri* complex one of the most difficult problems in the genus. However, plants of *E. chiangii* are not highly variable in morphology over the range of the species. Furthermore, the basal cluster of relatively broad basal leaves of *E. chiangii* apparently never occurs in *E. foliosus*. The pappus bristles of *E. chiangii* are fewer in number, and the achenes and disc flowers average considerably shorter in length. The range of *E. chiangii* is separated by a gap of over 1600 kilometers from the nearest populations of its putative relatives. Thus, despite a close similarity to some plants of *E. foliosus*, the distinctive combination of characters in *E. chiangii* which are rather consistent over the range of the species, the several characters distinct from those of *E. foliosus*, and the wide geographic disjunction of these two taxa, support the recognition of *E. chiangii* as a distinctive species.

In the genus *Erigeron* there are at present few known species with relatively wide geographic ranges which lack diploids somewhere within their range. If *E. chiangii* is composed only of tetraploid plants, as it seems, an allochthonous origin for this species is strongly implied. Diploids have been reported for *E. foliosus* and *E. breweri*, and despite the wide disjunction, the remarkable similarity of *E. chiangii* to forms of these species strongly suggests that they represent the primitive stock from which *E. chiangii* had its origin.

Evolutionary convergence might account for the similarities between these disjunct population systems. However, if *Erigeron chiangii* and *Erigeron foliosus* do not share a relatively recent common ancestry, the origin of *E. chiangii* is obscure since there is apparently no species in north central Mexico which is sufficiently phenotypically similar to *E. chiangii* to warrant its consideration as an ancestor.

Plants of *Erigeron bigelovii* A. Gray from Texas and northern Mexico have strongly imbricated, glandular phyllaries and relatively few ray flowers and might be mistaken for *Erigeron chiangii*. However, the former species has a woody base without caudex branches, highly branched and wiry stems, and spreading pubescence on the stems and leaves. The glands of *E. bigelovii* are uncolored, not conspicuously stipitate, and smaller than those of *E. chiangii*. No intergradation has been observed between these species, and they probably are not closely related.

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VASCULAR FLORA OF CEDAR GAP LAKE AND ENVIRONS, WEBSTER AND WRIGHT COUNTIES, MISSOURI

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ABSTRACT

The vascular flora of Cedar Gap Lake and environs in the Oak-Hickory Forest Region of southern Missouri are the focus of this study. An annotated list of 504 taxa from 87 families are recorded from Cedar Gap, the second most elevated point, 1694 feet, of the unglaciated, dissected Ozark Plateaus Province of the Interior Highlands. Twenty-one percent of the taxa are nonindigenous plants. One hundred twenty-six Webster County and 134 Wright County distributional records are documented.

The Oak-Hickory Association, the principal upland forest type in Missouri, is most extensive and highly developed in the unglaciated Ozarks Region (Braun, 1950). This association appears to have originated when the increased aridity of the Western Interior eliminated more mesic species of the Mixed Tertiary Forest from the western region of the Eastern Deciduous Forest Formation (Braun, 1955). The most elevated portion of the highly eroded Ozark Uplift in the Ozark Plateaus Province of the Interior Highlands is situated within the boundaries of Webster County and Wright County in southern Missouri (Steyermark, 1959). Fenneman (1938) stated, "Aside from the Boston Mountains the domed Ozark Plateau reaches its highest level near its center . . . at Cedar Gap where the upland surface is almost 1700 feet . . . in Wright County, Missouri." Steyermark (1963) reported Webster and Wright Counties as being among the least worked counties in documentation of vascular plants of the Missouri Ozarks. The purpose of this study is to present the first descriptive account of the vascular flora from an unique upland area within these counties, Cedar Gap Lake and vicinity.

A floristic study of this area was conducted semimonthly from June, 1974, through July, 1976. Four plant community types were recognized: A disturbed tall grass prairie strip restricted to the St. Louis-San Francisco Railroad right-of-way; a wet sedge-grass meadow around Cedar Gap Lake; a small oak-hickory woodland adjacent to the lake; and a waste ground community of general open disturbed habitats without any permanent structure.

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The 300 acre study site is located in the SW¼ S½ Section 15 and the NW¼ N½ N½ Section 22 of Wright County, and the SW¼ Section 16 of Webster County, T28N, R16W, of the Cedar Gap Quadrangle (Figure 1).

The topography consists of gently rolling to moderately sloping uplands with a mean gradient of two to twelve percent. The elevated, dissected Ozark Dome forms a part of the main dividing ridge between the tributaries of the Missouri River to the north and those of the White River to the south. This dividing ridge may be traced from the western limit of Webster County along the main line of the St. Louis-San Francisco Railroad. The bedrock is composed of resistant cherty, crinoidal limestones belonging to the Burlington-Keokuk Formations of the Osagean Series of the Mississippian System (McCracken, et al., 1961). Two small limestone sink-hole depressions within the study area are a feature of Karst topography.

The representative forest soil series, Wilderness Cherty Silt Loams, consist of moderately well-drained soils with cherty fragipans from nineteen to thirty-one inches in depth. Acid soil pH reactions range from 6.0 to 4.5. The surface layers are medium acid, brown, cherty silty loams and the subsoils are strongly acid, dark brown, cherty silty loams. The fragipans are pale brown, cherty silty loams overlying strong brown, cherty silty clays. The layers beneath the fragipans are very strongly acid, red to yellowish-red, cherty silty clays (USDA, Soil Conservation Service, 1975).

The continental climate in southern Missouri consists of wide seasonal variations in weather with typically hot, humid summers and cold winters. The mean annual temperature is 57.2° F. with mean temperatures of 31.4° F. during January and 78.6° F. through July. Total annual precipitation approximates 41.38 inches. The mean minimum precipitation of 1.96 inches occurs in January and the maximum precipitation of 5.28 inches falls in May. The mean growing season is 192 days with the first and last freeze occurring around October 23 and April 14 (McQuigg, 1969).

A tall grass prairie strip was sampled along a two-mile stretch of the St. Louis-San Francisco Railroad extending through Webster and Wright Counties. Several perennial prairie grasses and forbs, many weedy invaders, and a few woody members characterize this disturbed right-of-way situation. Local colonies of pioneer woody plants along fence row thickets have developed into the *Sassafras-Rhus-Diospyros* Associes of Steyermark (1940). In terms of species, most belong to the Compositae, Gramineae, Leguminosae, Rosaceae, Euphorbiaceae, and Asclepiadiaceae. Native perennial grasses include *Andropogon gerardii, A. virginicus, Schizachyrium scoparium, Elymus canadensis, Sorghastrum avenaceum, Tridens flavus, Eragrostis spectabilis, Koeleria pyramidata,* and *Panicum oligosanthes* var. *scribnerianum.*

Cedar Gap Lake, a 43.7 acre body of water, was created when the main line of the St. Louis-San Francisco Railroad was built in 1870. This eutrophic lake abuts the railway embankment and lies on the boundary line between Webster County and Wright County. Cedar Gap Lake formerly served as a

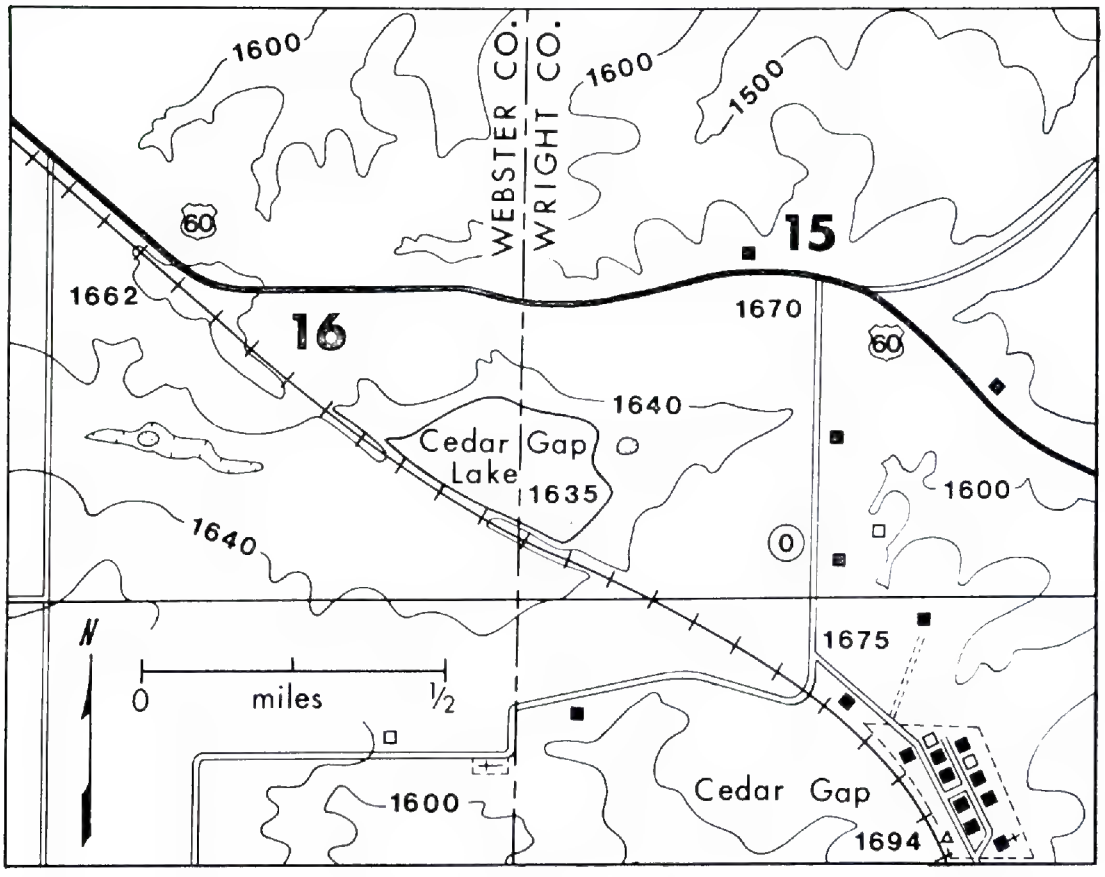

Figure 1. Cedar Gap Lake and environs along the St. Louis-San Francisco Railroad. Adapted from the Cedar Gap Quadrangle, Missouri, 7.5-minute series, USGS, 1951.

reservoir for steam locomotives from 1923 until 1951.

Vegetational zones around Cedar Gap Lake reveal generalized stages of hydrosere succession. Dominant emergent species are notably scarce except for extensive colonies of *Nelumbo lutea, Persicaria coccinea,* and *Potamogeton diversifolius.* Amphibious members along the muddy lake margin include clumps of *Alisma plantago-aquatica, Sagittaria latifolia, Typha latifolia,* and several species of *Carex, Eleocharis, Scirpus,* and *Juncus.* Common shrubs around the lake border are *Salix nigra, S. caroliniana,* and *Cephalanthus occidentalis.*

The extensive wet sedge-grass meadow surrounding Cedar Gap Lake is dominated by members of the Cyperaceae, Gramineae, and Juncaceae. Common sedges include *Carex lupulina, C. lurida, C. frankii, C. scoparia, C. vulpinoidea, Dulichium arundinaceum, Eleocharis quadrangulata,* and *Fimbristylis autumnalis.* Principal lowland prairie grasses interspersed throughout this wetland zone are *Spartina pectinata, Panicum virgatum, P. rigidulum, Phalaris arundinacea, Leersia oryzoides, Cinna arundinacea, Glyceria striata, Elymus virginicus, Agrostis stolonifera,* and *Tripsacum dactyloides.* Frequent

rushes consist of *Juncus interior, J. acuminatus, J. tenuis,* and *J. brachycarpus.* Common taxa of dense thickets include *Hibiscus lasiocarpos, Ribes missouriense, Polygonum scandens, Rubus pensylvanicus, Apios americana, Sambucus canadensis,* and *Rhus radicans.* Pastures, cultivated fields, and an oak-hickory woodland border the sedge-grass meadow zone.

The oak-hickory woodland at the eastern border of the lake adjacent to the railroad right-of-way has been derived from old pastures and orchards abandoned since 1905. Distinctive old field species, such as *Juniperus virginiana, Rhus aromatica, Andropogon virginicus,* and *Danthonia spicata,* are intermixed throughout the woodland. Important high understory and subcanopy species include *Sassafras albidum, Rhus copallina, R. glabra, Diospyros virginiana, Gleditsia triacanthos, Cornus florida, Amelanchier arborea, Ulmus rubra,* and *Viburnum rufidulum.* Major canopy trees are *Quercus stellata, Q. marilandica, Q. alba, Q. velutina, Carya tomentosa, C. ovata, C. texana, Prunus serotina, Nyssa sylvatica,* and *Celtis occidentalis.* A few fruit trees, *Pyrus malus* and *Prunus persica,* persist as orchard remnants.

According to Steyermark (1940), this subclimax forest type may be classified under the *Quercus marilandica-Quercus stellata* Associes converging through secondary succession into the probable climax forest type of more shade tolerant oaks and hickories, the *Quercus alba-Quercus velutina-Carya* Association. Steyermark (1959) described the Oak-Hickory Association as the most complex edaphic association in the Ozarks Region.

The waste ground community is rich in species composition, but it lacks the structural organization found in the older, more stabilized communities. Several open situations include pastures, fence row borders, cultivated fields, a fragipan road from the lake, highway roadsides along the right-of-way, and railroad track ballast. These disturbed habitats are normally colonized by a high number of ubiquitous native and nonindigenous weeds.

Voucher specimens are on deposit in the Herbarium of Southern Illinois University (SIU) for documentation of the annotated list of vascular plants. Duplicate sets of specimens for most species have been placed in the Herbaria of Northeast Louisiana University (NLU) and Southwest Missouri State University (SMS). Identification and nomenclature for all taxa follow Steyermark (1963), except for several more recent taxonomic changes presented by Correll and Johnston (1970). County voucher records are derived from county distribution maps found in the *Flora of Missouri* (Steyermark, 1963).

The annotated list is arranged alphabetically by family, genus, and species. Frequency of occurrence for each taxon is based upon field observations and field collections. This abundance scale had typical progression values of *common, frequent, infrequent,* and *rare.* An asterisk (*) before a taxon represents a new Webster County voucher, and a double asterisk (**) represents a new Wright County voucher. A triple asterisk (***) before a taxon indicates documentation with new representative voucher records for

both Webster and Wright Counties. Naturalized and introduced nonindigenous plant classifications follow the definitions of Lawrence (1951, p. 279). These appear after the community category and are represented by *N* or *I*, respectively.

The annotated list is comprised of 87 families, 295 genera, and 504 specific and subspecific taxa from Cedar Gap Lake and environs. One gymnosperm, three pteridophytes, 133 monocots, and 367 dicots are represented. The five largest families are: Compositae 67, Gramineae 66, Leguminosae 39, Cyperaceae 34, and Rosaceae 22. One hundred-seven taxa (21%) are nonindigenous plants. One hundred twenty-six Webster County and 134 Wright County distributional records are documented. The total species number, 504, constitutes fifteen percent of the vascular flora of Missouri based on Steyermark (1963).

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ANNOTATED LIST OF VASCULAR PLANTS

ACANTHACEAE

Ruellia humilis Nutt. Wild Petunia. Infrequent, railroad prairie strip.

ACERACEAE

Acer saccharinum L. Silver Maple. Rare, margin of Cedar Gap Lake.

AIZOACEAE

***Mollugo verticillata* L. Carpetweed. Infrequent, waste ground areas, N.

ALISMATACEAE

Alisma plantago-aquatica L. Water Plantain. Frequent, lake margin.
***Sagittaria latifolia* Willd. Arrowhead. Frequent, lake margin; sink-hole pond.

AMARANTHACEAE

****Amaranthus hybridus* L. Green Amaranth. Common, waste ground of railroad. N.
****Froelichia gracilis* (Hook.) Moq. Cottonweed. Common, railroad track ballast.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Coville. Yellow Stargrass. Frequent, railroad prairie.

ANACARDIACEAE

Rhus aromatica Ait. Fragrant Sumac. Common, open woodland; fence rows.
Rhus copallina L. Dwarf Sumac. Common, edge of woods; fence row borders.
Rhus glabra L. Smooth Sumac. Common, woodland borders; fence row thickets.
Rhus radicans L. Poison Ivy. Common, oak woods; sedge thickets; fence rows.

APOCYNACEAE

**Apocynum cannabinum* L. Indian Hemp. Common, railroad prairie strip.

ARACEAE

Acorus calamus L. Sweet Flag. Frequent, lake spillway; sink-hole pond. N.

ASCLEPIADACEAE

***Asclepias hirtella* (Pennell) Woodson. Green Milkweed. Frequent, prairie strip.
**Asclepias incarnata* L. Swamp Milkweed. Infrequent, wet sedge-grass meadow.
**Asclepias purpurascens* L. Purple Milkweed. Infrequent, open prairie strip.
****Asclepias syriaca* L. Common Milkweed. Common, railroad prairie strip.
Asclepias tuberosa L. var. *interior* (Woodson) Shinners. Butterfly Weed. Frequent, railroad prairie strip; roadsides.
Asclepias verticillata L. Horsetail Milkweed. Rare, railroad prairie strip.

BALSAMINACEAE

Impatiens capensis Meerb. Spotted Touch-me-not. Frequent, lake border.

BERBERIDACEAE

Podophyllum peltatum L. May Apple. Common, oak woodland; moist thickets.

BETULACEAE

Corylus americana Walt. Hazelnut. Frequent, fence rows; woodland edges.

BIGNONIACEAE

***Campsis radicans* (L.) Seem. Trumpet Creeper. Rare, mesic lake thickets.

BORAGINACEAE

Hackelia virginiana (L.) I. M. Johnston. Stickseed. Rare, prairie swale.
**Lithospermum arvense* L. Corn Cromwell. Frequent, waste ground areas. N.
Lithospermum canescens (Michx.) Lehm. Hoary Puccoon. Common, prairie strip.
****Myosotis virginica* (L.) BSP. Scorpion Grass. Infrequent, cultivated fields.

CALLITRICHACEAE

Callitriche heterophylla Pursh. Water Starwort. Rare, spillway overflow.
Callitriche terrestris Raf. Terrestial Starwort. Rare, prairie strip.

CAMPANULACEAE

Campanula americana L. Tall Bellflower. Rare, wet sedge-grass meadow.
Lobelia spicata Lam. Palespike Lobelia. Infrequent, railroad prairie.
Triodanis biflora (R. & P.) Greene. Venus' Looking Glass. Rare, prairie strip.
Triodanis perfoliata (L.) Nieuw. Venus' Looking Glass. Comming, prairie strip.

CAPPARIDACEAE

****Polanisia dodecandra* (L.) DC. Clammyweed. Frequent, railroad ballast.

CAPRIFOLIACEAE

Sambucus canadensis L. Elderberry. Common, sedge meadow; lake margin.
Symphoricarpos orbiculatus Moench. Coralberry. Common, fence rows; woods.

Triosteum angustifolium L. Yellow Horse Gentian. Infrequent, shaded woods.
Viburnum rufidulum Raf. Southern Black Haw. Frequent, oak woodland.

CARYOPHYLLACEAE

**Cerastium glomeratum* Thuill. Mouse-ear Chickweed. Common, waste ground. N.
**Cerastium vulgatum* L. Mouse-ear Chickweed. Common, waste ground areas. N.
****Dianthus armeria* L. Deptford Pink. Frequent, roadsides; disturbed ground. N.
***Saponaria officinalis* L. Bouncing Bet. Rare, railroad track ballast. N.
Silene antirrhina L. Sleepy Catchfly. Frequent, railroad prairie; roadsides.
Silene stellata (L.) Ait. Starry Campion. Rare, moist shaded woodland.
Silene virginica L. Fire Pink. Rare, cherty oak woodland.
**Stellaria media* (L.) Cyrillo. Common Chickweed. Common, waste ground. N.

CELASTRACEAE

Celastrus scandens L. American Bittersweet. Rare, oak woodland thicket.

CHENOPODIACEAE

****Chenopodium album* L. Lamb's Quarter. Common, open waste ground. N.

CISTACEAE

Lechea tenuifolia Michx. Pinweed. Infrequent, railroad prairie strip.

COMMELINACEAE

****Commelina communis* L. Dayflower. Infrequent, railroad track ballast. I.
Commelina erecta L. var. *angustifolia* (Michx.) Fern. Hierba del Pollo. Infrequent, lake border by old pumping station.
Tradescantia ohiensis Raf. Spiderwort. Common, railroad track ballast.

COMPOSITAE

**Achillea millefolium* L. Yarrow. Common, railroad prairie; pastures. N.
Ambrosia artemisiifolia L. Common Ragweed. Common, waste ground areas.
Ambrosia bidentata Michx. Lance-leaf Ragweed. Common, open waste ground.
Ambrosia trifida L. Giant Ragweed. Common, lake border; moist ditches.
Antennaria plantaginifolia (L.) Hook. Pussy's Toes. Frequent, open woods.
**Anthemis cotula* L. Mayweed. Infrequent, railroad ballast; roadsides. N.
***Arctium minus* (Hill) Bernh. Burdock. Rare, cultivated field edges. N.
Aster oblongifolius Nutt. var. *angustatus* Shinners. Aromatic Aster. Infrequent, oak-hickory woodland; fence rows.
Aster patens Ait. Spreading Aster. Frequent, oak-hickory woodland.
Aster pilosus Willd. var. *demotus* Blake. White Heath Aster. Common, railroad prairie strip; pastures; roadsides.
***Aster praealtus* Poir. Willow Aster. Rare, railroad right-of-way.
**Aster ptarmicoides* (Nees) T. & G. White Upland Aster. Rare, prairie strip.
**Bidens bipinnata* L. Spanish Needles. Frequent, disturbed open areas.
***Bidens frondosa* L. Sticktights. Infrequent, wet sedge-grass meadow.
***Bidens polylepis* Blake. Tickseed Sunflower. Common, lake margin; sedge meadow.
Carduus nutans L. Musk Thistle. Infrequent, railroad prairie; pastures. N.
Centaurea maculosa Lam. Star Thistle. Infrequent, railroad track ballast. N.
Chrysanthemum leucanthemum L. Ox-eye Daisy. Frequent, prairie strip; pastures. N.
Cichorium intybus L. Chicory. Frequent, roadsides; right-of-way strip. N.
**Cirsium altissimum* (L.) Spreng. Tall Thistle. Infrequent, pasture fields.
Cirsium vulgare (Savi) Tenore. Bull Thistle. Frequent, waste ground areas. N.
Coreopsis palmata Nutt. Prairie Coreopsis. Frequent, railroad prairie.

Echinacea pallida Nutt. Pale Coneflower. Infrequent, railroad prairie.
Erigeron annuus (L.) Pers. Daisy Fleabane. Common, waste ground areas.
Erigeron canadensis L. Horseweed. Common, open disturbed habitats.
Erigeron pulchellus Michx. Robin's Plantain. Infrequent, cherty woodland.
Erigeron strigosus Muhl. Whitetop. Common, roadsides; pastures.
*******Eupatorium perfoliatum* L. Throughout. Rare, wet sedge-grass meadow.
*******Eupatorium serotinum* Michx. Late Boneset. Frequent, sedge-grass meadow.
Gnaphalium obtusifolium L. Sweet Everlasting. Frequent, prairie strip.
******Gnaphalium purpureum* L. Purple Cudweed. Infrequent, open oak woodland.
******Heleastrum hemisphaericum* (Ait.) Shinners. Heleastrum. Rare, prairie strip.
Helenium flexuosum Raf. Purple-headed Sneezeweed. Common, prairie swales.
*******Helianthus annuus* L. Common Sunflower. Rare, railroad track ballast. I.
Helianthus grosseserratus Martens. Sawtooth Sunflower. Rare, lake margin.
Helianthus hirsutus Raf. Bristly Sunflower. Common, prairie strip; fields.
Helianthus mollis Lam. Ashy Sunflower. Common, railroad prairie strip.
*******Heliopsis helianthoides* (L.) Sweet. Ox-eye. Infrequent, railroad prairie.
******Heterotheca pilosa* (Nutt.) Shinners. Golden Aster. Rare, roadsides.
*******Iva annua* L. Marsh Elder. Rare, lake border by railroad tracks.
******Krigia biflora* (Walt.) Blake. False Dandelion. Rare, cherty moist woods.
******Krigia oppositifolia* Raf. Dwarf Dandelion. Rare, spillway border.
*******Kuhnia eupatorioides* L. False Boneset. Infrequent, railroad prairie strip.
********Lactuca canadensis* L. Wild Lettuce. Common, open waste ground.
********Lactuca serriola* L. Prickly Lettuce. Common, disturbed open habitats. N.
Liatris aspera Michx. Rough Blazing Star. Infrequent, prairie strip.
Liatris pycnostachya Michx. Prairie Blazing Star. Infrequent, prairie strip.
Parthenium hispidum Raf. American Feverfew. Common, railroad prairie strip.
Prenanthes aspera Michx. Rough White Lettuce. Rare, railroad prairie.
Pyrrhopappus carolinianus (Walt.) DC. False Dandelion. Frequent, roadsides.
Ratibida pinnata (Vent.) Barnh. Gray-headed Coneflower. Rare, prairie strip.
******Rudbeckia hirta* L. Black-eyed Susan. Common, right-of-way; pastures.
Rudbeckia triloba L. Brown-eyed Susan. Infrequent, oak woodland borders.
Silphium integrifolium Michx. Rosinweed. Infrequent, right-of-way thickets.
Solidago canadensis L. Tall Goldenrod. Common, pastures; prairie strip.
Solidago missouriensis Nutt. Missouri Goldenrod. Common, prairie strip.
Solidago nemoralis Ait. Old-field Goldenrod. Common, prairie strip; pastures.
******Solidago petiolaris* Ait. Goldenrod. Infrequent, field edges; woodland.
Solidago rigida L. Stiff Goldenrod. Rare, railroad prairie strip.
Solidago ulmifolia Muhl. Elm-leaf Goldenrod. Infrequent, fence rows.
********Taraxacum officinale* Wiggers. Dandelion. Common, pastures; prairie strip. N.
*******Tragopogon dubius* Scop. Goat's Beard. Infrequent, roadsides; track ballast. N.
******Verbesina helianthoides* Michx. Yellow Crownbread. Infrequent, field edge.
Vernonia arkansana DC. Fringed Ironweed. Infrequent, woodland thickets.
Vernonia baldwinii Torr. Western Ironweed. Frequent, right-of-way.
*******Vernonia missurica* Raf. Missouri Ironweed. Common, prairie strip; fields.
Xanthium strumarium L. Cocklebur. Infrequent, cultivated field edges.

CONVOLVULACEAE

********Calystegia sepium* (L.) R. Br. Hedge Bindweed. Infrequent, railroad thickets.
*******Convolvulus arvensis* L. Field Bindweed. Frequent, waste ground sites. N.
Cuscuta gronovii Willd. Dodder. Rare, moist lake border on *Solidago* spp.
Cuscuta pentagona Engelm. Dodder. Rare, prairie swale border.
********Cuscuta polygonorum* Engelm. Smartweed Dodder. Frequent, lake margin; wet sedge-grass meadow on *Polygonum* spp.

**Ipomoea hederacea* (L.) Jacq. Ivy-leaved Morning Glory. Infrequent, waste ground habitats. N.

Ipomoea lacunosa L. Small White Morning Glory. Rare, pasture fence row.

**Ipomoea pandurata* (L.) G.F.W. Meyer. Wild Potato. Infrequent, field edges.

***Ipomoea purpurea* (L.) Roth. Common Morning Glory. Rare, railway ballast. I.

CORNACEAE

Cornus florida L. Flowering Dogwood. Frequent, subcanopy of oak woods.

CRUCIFERAE

Barbarea vulgaris R. Br. var. *arcuata* (Opiz) Fries. Yellow Rocket. Common, pasture fields; roadsides; right-of-way. N.

**Brassica juncea* (L.) Coss. Indian Mustard. Infrequent, waste ground. N.

**Brassica kaber* (DC.) L.C. Wheeler var. *pinnatifida* (Stokes) L.C. Wheeler. Charlock. Infrequent, railroad ballast. N.

**Capsella bursa-pastoris* L. Shepherd's Purse. Infrequent, waste ground. N.

**Cardamine parviflora* L. var. *arenicola* (Britt.) O.E. Schultz. Bittercress. Frequent, disturbed open ground; cultivated fields.

Dentaria laciniata Muhl. Toothwort. Frequent, open cherty oak woodland.

**Descurainea pinnata* (Walt.) Britt. var. *brachycarpa* (Richards) Fern. Tansy Mustard. Infrequent, railroad prairie strip.

**Draba verna* L. Vernal Whitlow Grass. Rare, roadside; railway ballast. N.

**Lepidium campestre* (L.) R. Br. Fieldcress. Rare, waste ground by tracks. N.

Lepidium virginicum L. Peppergrass. Infrequent, pastures; right-of-way.

Sisymbrium officinale (L.) Scop. Hedge Mustard. Infrequent, railroad ballast. N.

***Thlaspi arvense* L. Field Pennycress. Frequent, roadsides; railroad ballast. N.

**Thlaspi perfoliatum* L. Perfoliate Pennycress. Rare, waste ground. N.

CUPRESSACEAE

Juniperus virginiana L. Red Cedar. Common, oak woods; pastures; fence rows.

CYPERACEAE

**Carex annectans* Bickn. Sedge. Frequent, moist ditches; sedge-grass meadow.

**Carex artitecta* Mackenz. Emmon's Sedge. Rare, cherty open woods.

**Carex bicknellii* Britt. Bicknell's Sedge. Infrequent, woodland border.

**Carex bushii* Mackenz. Bush's Sedge. Frequent, railroad prairie strip.

Carex cephalophora Muhl. Oval-headed Sedge. Rare, prairie swale.

**Carex crinita* Lam. Fringed Sedge. Infrequent, wet sedge-grass meadow.

Carex digitalis Willd. Sedge. Rare, oak-hickory shaded woods.

Carex frankii Kunth. Frank's Sedge. Common, lake margin; sedge meadow.

Carex gravida Bailey. Heavy Sedge. Rare, wetland sedge-grass meadow.

Carex hirsutella Mackenz. Hirsute Sedge. Infrequent, shaded oak woodland.

***Carex lupulina* Muhl. Hop Sedge. Common, wet sedge-grass meadow.

Carex lurida Wahlenb. Sedge. Common, lake margin; sedge-grass meadow.

Carex meadii Dewey. Sedge. Common, railroad prairie strip.

Carex molesta Mackenz. Sedge. Rare, roadside ditch along right-of-way.

Carex muhlenbergii Schk. Muhlenberg's Sedge. Rare, prairie swale by lake.

Carex scoparia Schk. Pointed Broomsedge. Common, sedge-grass meadow.

***Carex squarrosa* L. Squarrose Sedge. Frequent, sedge-grass meadow.

**Carex tribuloides* Wahlenb. Blunt Broomsedge. Frequent, sedge-grass meadow.

Carex vulpinoidea Michx. Fox Sedge. Common, lake margin; sedge meadow.

**Cyperus erythrorhizos* Muhl. Red-rooted Sedge. Infrequent, lake margin.

Cyperus esculentus L. Yellow Nutgrass. Infrequent, cultivated field edges.

Cyperus ovularis (Michx.) Torr. Hedgehog Clubrush. Frequent, prairie strip.

**Cyperus pseudovegetus* Steud. Umbrella Sedge. Rare, wet sedge-grass meadow.
Cyperus strigosus L. Flatsedge. Common, lake margin; sink-hole pond border.
***Dulichium arundinaceum* (L.) Britt. Three-way Sedge. Common, lake margins.
Eleocharis acicularis (L.) R. & S. Wire Spikerush. Common, muddy lake margin.
****Eleocharis obtusa* (Willd.) Schultes. Common Spikerush. Common, lake margin.
****Eleocharis smallii* Britt. Small's Spikerush. Common, sink-hole border.
***Eleocharis quadrangulata* (Michx.) R. & S. Square-stemmed Spikerush. Common, muddy lake margin; sink-hole border.
**Eleocharis tenuis* (Willd.) Schultes. var. *verrucosa* (Svenson) Svenson. Slender Spikerush. Frequent, lake margin; prairie swales.
Fimbristylis autumnalis (L.) R. & S. Autumn Sedge. Common, sedge meadow.
**Scirpus atrovirens* Willd. Common Bulrush. Infrequent, wet sedge meadow.
****Scirpus pendulus* Muhl. Bulrush. Common, roadside ditches; sedge meadow.
***Scirpus validus* Vahl. var. *creber* Fern. Great Bulrush. Frequent, lake spillway overflow; sink-hole pond margin.

DIOSCOREACEAE

Dioscorea villosa L. Wild Yam. Infrequent, shady oak-hickory woodland.

DIPSACACEAE

Dipsacus sylvestris Huds. Common Teasel. Infrequent, waste ground. N.

EBENACEAE

Diospyros virginiana L. Persimmon. Common, subcanopy of oak woods; fields.

EUPHORBIACEAE

Acalypha gracilens Gray. Three-seeded Mercury. Rare, railway ballast.
Acalypha virginica L. Three-seeded Mercury. Common, right-of-way area.
Croton capitatus Michx. Hogwort. Rare, waste ground of right-of-way.
***Croton glandulosa* L. var. *septentrionalis* Muell.-Arg. Sand Croton. Infrequent, cultivated field edge; railroad ballast.
Croton monanthogynus Michx. Prairie Tea. Common, waste ground habitats.
Euphorbia corollata L. Flowering Spurge. Common, railroad prairie strip.
**Euphorbia dentata* Michx. Wild Poinsettia. Frequent, waste ground sites.
Euphorbia maculata L. Nodding Spurge. Common, railway ballast; fields.
Euphorbia supina Raf. Milk Spurge. Infrequent, roadsides; railroad ballast.
Tragia betonicifolia Nutt. Noseburn. Rare, moist woodland thicket by tracks.

FAGACEAE

Quercus alba L. White Oak. Common, canopy of oak-hickory woodland.
Quercus marilandica Muenchh. Blackjack Oak. Common, oak woods; fence rows.
Quercus stellata Wang. Post Oak. Common, canopy of oak woods; fence rows.
Quercus velutina Lam. Black Oak. Common, canpy of oak woods; fence rows.

GENTIANACEAE

Gentiana puberulenta Pringle. Downy Gentian. Rare, railroad prairie strip.
Sabatia angularis (L.) Pursh. Rose Pink. Infrequent, roadside.

GERANIACEAE

**Erodium cicutarium* (L.) L' Her. Storksbill. Infrequent, waste ground N.
Geranium carolinianum L. Cranesbill. Common, disturbed waste ground.
Geranium maculatum L. Wild Geranium. Frequent, shaded oak woodland edges.

GRAMINEAE

**Aegilops cylindrica* Host. Jointed Goatgrass. Rare, railroad waste ground. N.
**Agropyron repens* (L.) Beauv. Quackgrass. Rare, cultivated field edges. N.
****Agrostis hyemalis* (Walt.) BSP. Ticklegrass. Frequent, waste ground areas.
***Agrostis stolonifera* L. Redtop. Common, sedge-grass meadow; pastures. I.
Andropogon gerardii Vitman. Big Bluestem. Common, railroad prairie strip.
Andropogon virginicus L. Broomsedge. Common, pastures; fields; prairie strip.
***Aristida dichotoma* Michx. Povertygrass. Infrequent, railroad right-of-way.
***Aristida longespica* Poir. Three-awn Grass. Rare, railway ballast.
**Aristida oligantha* Michx. Prairie Three-awn. Frequent, disturbed waste ground.
***Avena sativa* L. Oats. Rare, cultivated fields; railway ballast. I.
**Bromus commutatus* Schrad. Hairy Chess. Common, waste ground habitats. N.
****Bromus japonicus* Thumb. Japanese Chess. Common, railroad right-of-way. N.
****Bromus tectorum* L. Downy Chess. Common, waste ground habitats; fields. N.
Cenchrus longispinus (Hack.) Fern. Sandbur. Rare, cultivated field edges.
Cinna arundinacea L. Wood Reed. Common, sedge-grass wet meadow; lake margin.
****Dactylis glomerata* L. Orchard Grass. Common, fields; open pastures. I.
Danthonia spicata (L.) Beauv. Poverty Oatgrass. Frequent, open woods.
***Digitaria ischaemum* (Schreb.) Muhl. Smooth Crabgrass. Frequent, waste ground. N.
****Digitaria sanguinalis* (L.) Scop. Hairy Crabgrass. Common, open waste ground. N.
****Echinochloa crusgalli* (L.) Beauv. Barnyard Grass. Frequent, moist waste ground. N.
Eleusine indica (L.) Gaertn. Goose Grass. Infrequent, roadsides of tracks. N.
***Elymus canadensis* L. Canada Wild Rye. Frequent, railroad prairie strip.
Elymus virginicus L. Virginia Wild Rye. Frequent, sedge-grass meadow.
**Eragrostis cilianensis* (All.) Mosher. Stinkgrass. Rare, cultivated fields. N.
Eragrostis spectabilis (Pursh) Steud. Purple Lovegrass. Common, prairie strip.
Festuca obtusa Biehler. Nodding Fescue. Rare, moist shaded woodland.
**Festuca pratensis* Huds. Meadow Fescue. Common, fields; roadsides. I.
Glyceria striata (Lam.) Hitchc. Foul Manna Grass. Infrequent, sedge meadow.
****Hordeum pusillum* Nutt. Little Barley. Common, waste ground; roadsides.
***Hordeum vulgare* L. Barley. Rare, cultivated field edges; railroad ballast. I.
***Koeleria pyramidata* (Lam.) Beauv. Junegrass. Infrequent, prairie strip.
**Leersia oryzoides* (L.) Sw. Rice Cutgrass. Common, wet sedge-grass meadow.
Leptochloa filiformis (Lam.) Beauv. Red Sprangletop. Rare, cultivated field.
**Lolium perenne* L. Perennial Ryegrass. Infrequent, roadside waste ground. I.
Muhlenbergia schreberi J.F. Gmel. Nimblewill Muhly. Infrequent, roadsides.
Panicum anceps Michx. Infrequent, wet sedge-grass meadow.
**Panicum capillare* L. Witchgrass. Common. disturbed open ground.
**Panicum clandestinum* L. Broad-leaved Panicum. Rare. woodland border.
***Panicum dichotomiflorum* Michx. Fall Panicum. Common, railroad waste ground.
Panicum lanuginosum Ell. Panic Grass. Common, sedge-meadow; prairie swales.
Panicum linearifolium Scribn. Panic Grass. Infrequent, open cherty woods.
Panicum lindheimeri Nash. Panic Grass. Common, sedge meadow; prairie swales.
Panicum oligosanthes Schultes var. *scribnerianum* (Nash) Fern. Panic Grass. Frequent, railroad prairie strip.
Panicum rigidulum Bosc. Munro Grass. Common, prairie swale; sedge meadow.
Panicum virgatum L. Switchgrass. Frequent, wet sedge-grass meadow.
Paspalum laeve Michx. Lens Grass. Common, lake margin; prairie swales.
***Paspalum pubiflorum* Poir. var. *glabrum* Vasey. Beadgrass. Infrequent, moist waste ground; roadsides.

***Phalaris arundinacea* L. Reed Canary Grass. Common, wet sedge-grass meadow.
Phleum pratense L. Timothy. Frequent, pastures; cultivated fields. I.
Poa annua L. Annual Bluegrass. Rare, waste ground site. N.
**Poa pratensis* L. Kentucky Bluegrass. Common. prairie strip; pastures. I.
**Schizachyrium scoparium* (Michx.) Nash. Little Bluestem. Common, prairie strip.
**Secale cereale* L. Rye. Infrequent, roadsides; railroad ballast. I.
****Setaria faberii* Herrm. Giant Foxtail. Common, open waste ground. N.
****Setaria glauca* (L.) Beauv. Yellow Foxtail. Common, waste ground. N.
**Setaria viridis* (L.) Beauv. Green Foxtail. Infrequent, railroad ballast. N.
Sorghastrum avenaceaum (Michx.) Nash. Indian Grass. Common, prairie strip.
**Sorghum bicolor* (L.) Moench. Sorghum. Rare, cultivated fields; right-of-way. I.
**Sorghum halepense* (L.) Pers. Johnson Grass. Common, sedge meadow; fields. I.
**Spartina pectinata* Link. Prairie Cordgrass. Frequent, sedge-grass meadow.
**Sporobolus vaginiflorus* (Torr.) Wood. Poverty Dropseed. Rare, pastures.
Tridens flavus (L.) Hitchc. Purpletop. Common, prairie strip; roadsides.
**Tripsacum dactyloides* L. Eastern Gamagrass. Infrequent, sedge meadow.
****Triticum aestivum* L. Wheat. Rare, cultivated fields; railway ballast. I.
Vulpia octoflora (Walt.) Rydb. Six-weeks Fescue. Frequent, pastures; woods.
**Zea mays* L. Corn. Rare, railway ballast. I.

HALORAGIDACEAE

**Prosperpinaca palustris* L. Mermaid Weed. Rare, sink-hole pond; lake spillway.

HYPERICACEAE

**Hypericum drummondii* (Grev. & Hook.) T. & G. Nits-and-lice. Rare, prairie strip.
Hypericum gentianoides (L.) BSP. Pineweed. Rare, railroad prairie strip.
Hypericum mutilum L. Dwarf St. Johns-wort. Frequent, muddy lake margin.
Hypericum perforatum L. Common St. Johns-wort. Frequent, prairie trip. N.
Hypericum punctatum Lam. Spotted St. Johns-wort. Frequent, prairie strip.

IRIDACEAE

Sisyrinchium angustifolium Mill. Blue-eyed Grass. Rare, cherty woodland.
**Sisyrinchium campestre* Bickn. Prairie Blue-eyed Grass. Common, railroad prairie.

JUGLANDACEAE

Carya ovata (Mill.) K. Koch. Shagbark Hickory. Common, canopy of oak woods.
Carya texana Buckl. Black Hickory. Frequent, canopy of oak-hickory woodland.
Carya tomentosa Nutt. Mockernut Hickory. Common, canopy of oak woodland.
Juglans nigra L. Black Walnut. Infrequent, open pasture lands.

JUNCACEAE

**Juncus acuminatus* Michx. Sharp-pointed Rush. Frequent, sedge meadow; swales.
Juncus brachycarpus Engelm. Short-fruited Rush. Common, sedge meadow; swales.
Juncus dudleyi Wieg. Dudley's Rush. Rare, roadside ditches; sedge meadow.
****Juncus interior* Wieg. Inland Rush. Common, sedge meadow; lake border.
**Junicus nodatus* Coville. Rush. Infrequent, prairie swale; wet depressions.
Juncus tenuis Willd. Slender Rush. Common, roadsides; field edges.
Luzula bulbosa (Wood) Rydb. Wood Rush. Frequent, cherty open woodland.

LABIATAE

Cunila origanoides (L.) Britt. Stone Mint. Infrequent, cherty oak woods.
Hedeoma hispida Pursh. Mock Pennyroyal. Rare, railroad prairie strip.
Isanthus brachiatus (L.) BSP. False Pennyroyal. Rare, moist lake margin.

***Lamium amplexicaule* L. Henbit. Frequent, open ground; roadsides. N.
***Lamium purpureum* L. Dead Nettle. Infrequent, roadside embankments. N.
***Lycopus rubellus* Moench. Water Horehound. Common, lake margin; sink-holes.
***Lycopus virginicus* L. Virginia Bugleweed. Infrequent, sedge-grass meadow.
Monarda fistulosa L. Wild Bergamot. Frequent, woodland edges; prairie strip.
Perilla frutescens (L.) Britt. Beefsteak Plant. Rare, moist embarkment. N.
Physostegia virginiana (L.) Benth. False Dragonhead. Rare, shaded thicket.
**Prunella vulgaris* L. var. *lanceolata* (Bart.) Fern. Self-Heal. Common, field edges; pastures; right-of-way; lake border.
Pycnanthemum tenuifolium Schrad. Slender Mountain Mint. Frequent, prairie strip; woodland border.
Scutellaria lateriflora L. Mad-dog Skullcap. Infrequent, muddy lake margin.
**Scutellaria ovata* Hill. Heart-leaved Skullcap. Rare, cherty oak woodland.
Scutellaria parvula Michx. Small Skullcap. Infrequent, open prairie strip.
Teucrium canadense L. Wood Sage. Common, woodland edges; prairie strip.

LAURACEAE

Sassafras albidum (Nutt.) Nees. Sassafras. Common, subcanopy of oak woodland; fence row thickets.

LEGUMINOSAE

Amorpha canescens Pursh. Lead Plant. Rare, railroad prairie strip; fence row.
Apios americana Medic. Ground Nut. Common, wet sedge-grass thickets.
**Baptisia leucantha* T. & G. White Wild Indigo. Frequent, railroad prairie.
**Baptisia leucophaea* Nutt. Long-bracted Wild Indigo. Frequent, prairie strip.
Cassia fasciculata Michx. Partridge Pea. Common, disturbed right-of-way.
Cassia nictitans L. Sensitive Pea. Infrequent, cherty open woods.
Cercis canadensis L. Red Bud. Infrequent, subcanopy of oak-hickory woods.
**Crotalaria sagittalis* L. Rattlepod. Common, railroad prairie strip.
**Desmanthus illinoensis* (Michx.) MacM. ex Robins. & Fern. Illinois Mimosa. Rare, prairie strip.
Desmodium ciliare (Muhl.) DC. Hairy Tick Trefoil. Frequent, prairie strip.
**Desmodium illinoense* Gray. Illinois Tick Trefoil. Frequent, prairie strip.
Desmodium marilandicum (L.) DC. Small-leaf Tick Trefoil. Rare, oak woods.
Desmodium paniculatum (L.) DC. Panicled Tick Trefoil. Common, prairie strip.
Desmodium rotundifolium DC. Round-leaf Tick Trefoil. Infrequent, open woods.
Desmodium sessilifolium (Torr.) T. & G. Sessile-leaf Tick Trefoil. Frequent, railroad right-of-way strip.
Gleditsia triacanthos L. Honey Locust. Infrequent, open oak woods; pastures.
Lespedeza capitata Michx. Round-headed Bush Clover. Frequent, prairie strip.
***Lespedeza cuneata* (Dumont) G. Don. Sericea Lespedeza. Common, waste ground. I.
Lespedeza procumbens Michx. Trailing Lespedeza. Infrequent, open woodland.
***Lespedeza stipulacea* Maxim. Korean Lespedeza. Frequent, waste ground. I.
Lespedeza striata (Thunb.) H. & A. Japanese Lespedeza. Rare, roadsides. I.
Lespedeza violacea (L.) Pers. Violet Prairie Clover. Frequent, railroad prairie.
Lespedeza virginica (L.) Britt. Slender Bush Clover. Common, railroad prairie.
Medicago lupulina L. Black Medic. Infrequent, roadside waste ground. N.
***Medicago sativa* L. Alfalfa. Frequent, pastures; roadsides; field edges. I.
Melilotus albus Desr. White Sweet Clover. Common, roadsides; pastures. I.
**Melilotus officinalis* (L.) Lam. Yellow Sweet Clover. Frequent, waste ground. I.
Petalostemum candidum (Willd.) Michx. White Prairie Clover. Rare, prairie strip.
Petalostemum purpureum (Vent.) Rydb. Purple Prairie Clover. Rare, prairie strip.

Psoralea psoralioides (Walt.) Cory. var. *eglandulosa* (Ell.) Freeman. Sampson's Snakeroot. Common, railroad prairie strip.
Schrankia uncinata Willd. Sensitive Brier. Frequent, railroad prairie strip; open woodland.
Strophostyles helvola (L.) Ell. Wild Bean. Rare, fence thicket; roadside.
Stylosanthes biflora (L.) BSP. Pencil Flower. Common, open woods; prairie strip.
Tephrosia virginiana (L.) Pers. Goat's Rue. Frequent, open woods; prairie strip.
**Trifolium campestre* Schreb. Large Hop Clover. Common, waste ground. N.
**Trifolium pratense* L. Red Clover. Frequent, fields; roadsides. N.
**Trifolium reflexum* L. Buffalo Clover. Rare, roadsides. N.
Trifolium repens L. White Clover. Common, disturbed waste places. N.
Vicia dasycarpa Tenore. Hairy-fruited Vetch. Infrequent, railroad ballast. N.

LILIACEAE

Allium canadense L. Wild Onion. Frequent, pastures; railroad prairie strip.
**Allium sativum* L. Garlic. Rare, railway ballast edge. I.
Allium vineale L. Field Garlic. Infrequent, roadsides; pasture fields. N.
****Asparagus officinalis* L. Garden Asparagus. Infrequent, field edges. I.
**Camassia scilloides* (Raf.) Cory. Wild Hyacinth. Infrequent, prairie strip.
Erythronium albidum Nutt. White Trout Lily. Infrequent, cherty oak woods.
***Melanthium virginicum* L. Bunch Flower. Rare, wet sedge-grass meadow edge.
Nothoscordum bivalve (L.) Britton. False Garlic. Common, prairie strip; fields; woodland edge.
Polygonatum biflorum (Walt.) Ell. Solomon's Seal. Infrequent, shady oak woods.
Smilacina racemosa (L.) Desf. False Solomon's Seal. Frequent, moist oak woods.
Smilax bona-nox L. Catbrier. Infrequent, open woods; fence rows; roadside.
Smilax hispida Muhl. Bristly Greenbrier. Infrequent, shaded oak woodland.

LINACEAE

Linum sulcatum Riddell. Yellow Flax. Rare, railroad prairie strip.

LOASACEAE

****Menzelia oligosperma* Nutt. Stick-leaf. Frequent, railroad ballast.

LYTHRACEAE

Cuphea petiolata (L.) Koehne. Clammy Cuphea. Frequent, open waste ground.
Rotala ramosior (L.) Koehne. Toothcup. Infrequent, muddy lake margin.

MALVACEAE

Abutilon theophrasti Medic. Velvetleaf. Infrequent, railroad ballast; fields. N.
**Althaea rosea* L. Hollyhock. Rare, railroad ballast. I.
Callirhoe digitata Nutt. Poppy Mallow. Rare, open cherty woods.
**Hibiscus lasiocarpos* Cav. Woolly Rose Mallow. Common, lake margin; sedge meadow.
***Sida spinosa* L. Prickly Mallow. Infrequent, cultivated field edges. N.

MORACEAE

***Morus alba* L. White Mulberry. Rare, cultivated field edge; oak woods. I.

NYCTAGINACEAE

****Mirabilis nyctaginea* (Michx.) MacM. Four O'Clock. Common, railroad ballast.

NYMPHACEAE

***Nelumbo lutea* (Willd.) Pers. American Lotus. Common, emergent in lake.

NYSSACEAE

**Nyssa sylvatica* Marsh. Sour Gum. Infrequent, subcanopy of oak-hickory woods.

OLEACEAE

Fraxinus americana L. White Ash. Infrequent, oak-hickory woodland.

ONAGRACEAE

Gaura biennis L. Biennial Gaura. Infrequent, railroad prairie strip.

***Ludwigia alternifolia* L. Seedbox. Common, lake margin; sink-hole pond border.

Ludwigia palustris (L.) Ell. var. *americana* (DC.) Fern. Marsh Purslane. Common, muddy lake margin; sink-hole pond.

**Oenothera biennis* L. Common Evening Primrose. Common, moist waste ground.

****Oenothera laciniata* Hill. Ragged Evening Primrose. Infrequent, waste ground.

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. Rattlesnake Fern. Infrequent, moist oak woodland; sink-hole pond embankment.

ORCHIDACEAE

**Spiranthes cernua* (L.) Richard. Nodding Ladies Tresses. Rare, prairie strip.

**Spiranthes gracilis* (Bigel.) Beck. Green-lipped Ladies Tresses. Rare, railroad prairie strip.

OXALIDACEAE

***Oxalis dillenii* Jacq. Yellow Wood Sorrel. Frequent, waste ground.

Oxalis violacea L. Violet Wood Sorrel. Frequent, open woods; railroad prairie.

PASSIFLORACEAE

Passiflora lutea L. var. *glabriflora* Fern. Passion Flower. Rare, shaded woods.

PHYTOLACCACEAE

Phytolacca americana L. Pokeweed. Common, disturbed open ground.

PLANTAGINACEAE

Plantago aristata Michx. Bracted Plantain. Frequent, open disturbed areas.

Plantago lanceolata L. English Plantain. Infrequent, waste ground; roadsides. N.

****Plantago rugelii* Dcne. Rugel's Plantain. Frequent, roadside; woods border.

Plantago pusilla Nutt. Small Plantain. Rare, railroad prairie strip.

Plantago virginica L. Hoary Plantain. Infrequent, railroad prairie strip.

POLEMONIACEAE

Phlox pilosa L. Prairie Phlox. Infrequent, railroad prairie strip.

POLYGALACEAE

**Polygala incarnata* L. Pink Milkwort. Rare, railroad prairie strip.

***Polygala sanguinea* L. Field Milkwort. Common, railroad prairie strip.

Polygala senega L. Seneca Snakeroot. Rare, moist shaded woodland by lake.

POLYGONACEAE

***Persicaria coccinea* (Muhl.) Greene. Water Smartweed. Common, emergent in sink-hole pond; Cedar Gap Lake.

Persicaria hydropiperoides (Michx.) Small. Mild Water Pepper. Common, lake margin; prairie swales; sedge-grass meadow.

Persicaria lapathifolia (L.) Small. Pale Smartweed. Frequent, lake margin. N.

Persicaria pensylvanica (L.) Small. Pinkweed. Common, lake margin; swales.
Persicaria punctata (Ell.) Small. Smartweed. Rare, lake border by spillway.
***Polygonum aviculare* L. Knotweed. Frequent, disturbed open waste ground. N.
Polygonum scandens L. False Buckwheat. Frequent, wet sedge-grass meadow thickets.
Polygonum virginianum L. Virginia Knotweed. Rare, moist shaded oak woods.
Rumex acetosella L. Red Sheep Sorrel. Common, throughout waste ground. N.
***Rumex crispus* L. Sour Dock. Common, waste ground habitats. N.

POLYPODIACEAE

Asplenium platyneuron (L.) Oakes. Ebony Spleenwort. Rare, cherty embankment.
Pteridium aquilinum (L.) Kuhn. Bracken Fern. Rare, cherty open woodland next to right-of-way.

PORTULACACEAE

Claytonia virginica L. Spring Beauty. Frequent, open woods; pastures.

POTAMOGETONACEAE

Potamogeton diversifolius Raf. Pondweed. Common, emergent of Cedar Gap Lake.

PRIMULACEAE

Dodecatheon meadia L. Shooting Star. Infrequent, railroad prairie strip.
***Lysimachia hybrida* Michx. Loosestrife. Rare, lake margin thicket.
Lysimachia lanceolata Walt. Loosestrife. Frequent, moist shaded woodland.

RANUNCULACEAE

Anemone virginiana L. Thimbleweed. Infrequent, cherty open woods.
Anemonella thalictroides (L.) Spach. Rue Anemone. Rare, cherty open woods.
***Delphinium ajacis* L. Rocket Larkspur. Rare, roadside. I.
Delphinium carolinianum Walt. var. *crispum* Perry. Wild Blue Larkspur. Infrequent, railroad right-of-way.
***Delphinium tricorne* Michx. Dwarf Larkspur. Rare, cherty moist woodland.
Ranunculus abortivus L. Small-flowered Crowfoot. Common, waste ground.
Ranunculus fascicularis Muhl. var. *apricus* (Greene) Fern. Prairie Buttercup. Frequent, cherty oak woodland; prairie strip.
***Ranunculus laxicaulis* (T. & G.) Darby. Spearwort. Frequent, sedge meadow.
Ranunculus micranthus Nutt. Small-flowered Buttercup. Rare, cultivated field.
***Thalictrum revolutum* DC. Waxy Meadow-rue. Infrequent, railroad prairie.

RHAMNACEAE

Ceanothus americanus L. var. *pitcheri* T. & G. New Jersey Tea. Frequent, railroad prairie strip; open woods.

ROSACEAE

Agrimonia parviflora Ait. Swamp Agrimonia. Rare, sedge-grass meadow edge.
Amelanchier arborea (Michx. f.) Fern. Shadbush. Infrequent, oak-hickory woods.
Crataegus crusgalli L. Cockspur Hawthorn. Rare, fence row thicket.
Fragaria virginiana Duchesne. Wild Strawberry. Common, prairie strip; woods.
Geum canadense Jacq. var. *camporum* (Rydb.) Fern. White Avens. Infrequent, moist shaded woods near lake.
Gillenia stipulata (Muhl.) Trel. Indian Physic. Infrequent, cherty woodland.
***Potentilla norvegica* L. Rough Cinquefoil. Rare, spillway ditch. N.
Potentilla recta L. Sulfur Cinquefoil. Common, disturbed ground habitats. N.
Potentilla simplex Michx. Old-field Cinquefoil. Common, oak woodland; railroad

prairie strip.
***Prunus hortulana* Bailey. Hortulan Plum. Rare, fence row border. I.
***Prunus mahaleb* L. Mahaleb Cherry. Rare, oak woodland border. I.
Prunus munsoniana Wight & Hedrick. Wild Goose Plum. Rare, fence rows.
**Prunus persica* (L.) Batsch. Peach. Rare, remnant from old orchard. I.
***Prunus serotina* Ehrh. Wild Black Cherry. Infrequent, subcanopy of oak woods.
**Pyrus ioensis* (Wood) Bailey. Wild Crab Apple. Rare, pasture field edge.
***Pyrus malus* L. Apple. Infrequent, old orchard remnants in woods. I.
Rosa carolina L. Pasture Rose. Frequent, pastures; prairie strip; woods.
Rosa multiflora Thunb. Multiflora Rose. Infrequent, fence row thickets. I.
Rosa setigera Michx. Prairie Rose. Infrequent, pastures; prairie strip.
**Rubus flagellaris* Willd. Northern Dewberry. Common, fence rows; prairie strip; woodland thickets.
Rubus occidentalis L. Black Raspberry. Rare, mesic shaded woodland thickets.
***Rubus pensylvanicus* Poir. Highbush Blackberry. Common, pastures; fields; railroad prairie strip; roadsides; sedge thickets.

RUBIACEAE

Cephalanthus occidentalis L. Buttonbush. Common, lake margin; sink-hole pond.
Diodia teres Walt. Rough Buttonweed. Common, waste ground habitats.
Galium aparine L. Cleavers. Frequent, mesic oak woods; sedge meadow.
***Galium obtusum* Bigel. Blunt-leaf Bedstraw. Rare, shaded oak woods.
***Galium tinctorium* L. Stiff Bedstraw. Frequent, sink-hole pond border.
***Galium virgatum* Nutt. Dwarf Bedstraw. Rare, railroad prairie strip.
Hedyotis crassifolia Raf. Small Bluets. Common, pastures; prairie strip.
Hedyotis longifolia (Gaertn.) Fosb. Long-leaved Bluets. Infrequent, railroad prairie strip.
Hedyotis nigricans (Lam.) Fosb. Narrow-leaved Bluets. Rare, cherty woods.

SALICACEAE

Salix caroliniana Michx. Ward's Willow. Frequent, lake margin.
Salix humilis Marsh. Prairie Willow. Infrequent, prairie strip; field edge.
***Salix nigra* Marsh. Black Willow. Common, lake margin; sink-hole pond.

SANTALACEAE

Comandra richardsiana Fern. False Toadflax. Common, railroad prairie strip.

SAXIFRAGACEAE

**Heuchera richardsonii* R. Br. Prairie Alumroot. Rare, railroad prairie.
**Penthorum sedoides* L. Ditch Stonecrop. Common, lake margin; sedge meadow.
Ribes missouriense Nutt. Missouri Gooseberry. Frequent, oak woods; fence rows.

SCROPHULARIACEAE

****Agalinus tenuifolia* (Vahl.) Raf. Slender False Foxglove. Frequent, lake margin.
***Lindernia dubia* (L.) Pennell. False Pimpernal. Infrequent, muddy lake margin.
Mimulus ringens L. Monkey Flower. Frequent, sedge-grass meadow zone.
Pedicularis canadensis L. Lousewort. Infrequent, open cherty woodland.
Penstemon pallidus Small. Pale Beard-tongue. Frequent, railroad prairie.
Penstemon tubaeflorus Nutt. Beard-tongue. Infrequent, railroad prairie.
Scrophularia marilandica L. Late Figwort. Common, lake border; sedge meadow.
***Verbascum blattaria* L. Moth Mullein. Rare, railroad ballast; roadside. N.
Verbascum thapsus L. Common Mullein. Infrequent, waste ground habitats. N.
Veronica arvensis L. Corn Speedwell. Frequent, disturbed open ground. N.
***Veronica peregrina* L. Purslane Speedwell. Infrequent, waste ground sites.

Veronicastrum virginicum (L.) Farw. Culver's Root. Rare, railroad prairie.

SOLANACEAE

Datura stramonium L. var. *tatula* (L.) Torr. Jimson Weed. Infrequent, railway ballast; cultivated fields.
Physalis heterophylla Nees. Clammy Ground Cherry. Rare, railroad ballast.
Physalis subglabrata Mack. & Bush. Smooth Physalis. Frequent, waste ground.
***Solanum americanum* Mill. Black Nightshade. Rare, cultivated fields.
Solanum carolinense L. Horse Nettle. Common, pastures; roadsides; fields.

TYPHACEAE

Typha latifolia L. Cat-tail. Common, lake margin; prairie swales; ditches.

ULMACEAE

***Celtis occidentalis* L. Hackberry. Infrequent, oak woods; sink-hole pond border.
Ulmus alata Michx. Winged Elm. Infrequent, open oak-hickory woods.
Ulmus americana L. American Elm. Infrequent, oak woods; pasture edges.
Ulmus rubra L. Slippery Elm. Common, oak woodland; fence rows; pastures.

UMBELLIFERAE

Angelica venenosa (Greenway) Fern. Wood Angelica. Rare, prairie swale.
**Chaerophyllum procumbens* (L.) Crantz. Wild Chervil. Common, waste ground.
Cicuta maculata L. Water Hemlock. Common, lake margin; sedge-grass meadow.
Daucus carota L. Wild Carrot. Common, roadsides; pastures; prairie strip. N.
Eryngium yuccifolium Michx. Rattlesnake Master. Rare, railroad prairie strip.
**Pastinaca sativa* L. Wild Parsnip. Rare, railway ballast. N.
Polytaenia nuttallii DC. Prairie Parsley. Infrequent, railroad prairie.
***Sanicula canadensis* L. Black Snakeroot. Infrequent, shaded cherty woods.
Torilis japonica (Houtt.) DC. Hedge Parsley. Common, waste ground sites. N.
Zizia aurea (L.) Koch. Golden Alexanders. Rare, wet sedge-grass meadow.

URTICACEAE

Boemeria cylindrica (L.) Sw. False Nettle. Infrequent, damp sedge meadow.
Pilea pumila (L.) Gray. Clearweed. Infrequent, shaded mesic lake border.

VALERIANACEAE

Valerianella radiata (L.) Dufr. Corn Salad. Common, waste ground habitats.

VERBENACEAE

Phyla lanceolata (Michx.) Greene. Frog-Fruit. Infrequent, lake margin.
**Verbena bracteata* Lag. & Rodr. Prostrate Vervain. Rare, roadside to lake.
Verbena canadensis L. Rose Vervain. Infrequent, railroad prairie strip.
Verbena hastata L. Blue Vervain. Frequent, wet sedge-grass meadow.
Verbena simplex Lehm. Narrow-leaved Vervain. Frequent, waste ground areas.
Verbena stricta Vent. Hoary Vervain. Infrequent, pastures; roadsides.
Verbena urticifolia L. White Vervain. Common, lake margin; sedge meadow.

VIOLACEAE

***Viola missouriensis* Greene. Missouri Violet. Rare, cherty woodland.
Viola pedata L. Bird-foot Violet. Frequent, railroad prairie; oak woods.
Viola pratincola Greene. Common Blue Violet. Frequent, fields; oak woods.
Viola rafinesquii Greene. Field Pansy. Common, prairie strip; pastures. N.
**Viola sagittata* Ait. Arrow-leaved Violet. Infrequent, railroad prairie.

VITACEAE

****Parthenocissus quinquefolia*** (L.) Planch. Virginia Creeper. Infrequent, oak-hickory woodland.

Vitis aestivalis Michx. Summer Grape. Infrequent, oak-hickory woodland.

Vitis cinerea Engelm. Grayback Grape. Frequent, oak-hickory woods; thickets.

Vitis vulpina L. Frost Grape. Infrequent, oak woodland thickets by lake.

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TAXONOMIC NOTES AND NEW SECTIONS OF *CLITORIA* SUBGENUS *BRACTEARIA* (LEGUMINOSAE)[1]

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Botanists have traditionally followed Bentham (1858) recognizing three natural groups in the genus *Clitoria*, treating them as sections, and ignoring Baker (1879) who elevated two of them to the level of subgenus. Species with woody habits (i.e. trees, tall shrubs, and woody vines) are usually included in section *Clitorianthes* Bentham. The name *Clitorianthes* is a superfluous name for *Bractearia* Martius ex Bentham (1837). In recent monographic studies of *Clitoria*, Fantz (1977) concluded that these three natural groups, on the basis of morphological and distributional data, supported by the scant cytological and developmental data available, should be treated at the subgeneric level. The subgenus of woody members contains half of the 58 species in *Clitoria*, a number of which are endemic to certain refugia recognized by Prance (1973) and as yet undescribed. The 29 species of this subgenus can be segregated into four sections. This paper provides taxonomic notes on subgenus *Bractearia* and describes the new sections and two new species.

In his revisionary treatment of *Clitoria*, Bentham (1837) recognized three sections. Section *Bractearia* Mart. was described for the first time by fruticose habit, trifoliolate leaves and bracteoles equal to or longer than the calyx. Bentham included five species in this section: *C. amazonum* Mart. ex Benth., *C. acuminata* Benth., *C. racemosa* Benth., *C. poitaei* DC., and *C. arborea* Benth.

In an article on plants collected by Schomburgk in British Guiana, Bentham (1839) substituted the name *Dendrocyamus* for *Bractearia* justifying the change by the fact that *Bractearia* was used as a generic epithet in the Rubiaceae and as a sectional epithet in the genus *Chaetogastra* (Melastomataceae).

Although Bentham (1858) continued to recognize three sections in *Clitoria*, he again substituted a new name for the woody section, now calling it *Clitorianthes*. No comment was made on the changed named, nor was reference made to any pre-existing names for this section. Bentham here changed the sectional diagnosis of section *Clitorianthes* to erect shrubs or

[1] Taxonomic studies on *Clitoria* accomplished at the IFAS Herbarium, Dept. of Botany, University of Florida, Gainesville, Florida. Florida Agricultural Experiment Station Journal Series No. 1344.

tall climbers with three leaflets and a flat or slightly convex, coriaceous legume. He further divided the nine species in section *Clitorianthes* into two unnamed groups distinguished by the bracteoles. The first group included six species with bracteoles narrow or much shorter than the calyx. Of the six species included, only *Clitoria arborescens* (synonym: *C. poitaei* DC.) had figured in his original list of 1837. The second group was characterized by ovate coriaceous bracteoles subequal to the calyx. All three species now placed in this group had been assigned to this section in 1837. Their names now were reported as *C. amazonum* Mart.. ex Benth. (synonym: *C. acuminata* Benth.), *C. hoffmannseggii* (a superfluous name for *C. arborea* Benth.) and *C. racemosa* Benth.

Publications of the next century which included *Clitoria* were primarily of a floristic nature. Authors adopted Bentham's treatment and used the name *Clitorianthes* for the section which included the woody species. Baker (1879), in a floristic treatment of legumes in India, elevated two of Bentham's sectional names to the level of subgenus. Section *Clitorianthes* Benth. was not included in this revisionary change, presumably because none of its species occur in India. No other floristic work on *Clitoria* has recognized Baker's treatment of subgenera, the genus always being divided into sections following Bentham's treatment of 1858.

In the first monographic treatment of the genus in the past century, Fantz (1977) concluded that the three natural groups can be distinguished morphologically by the fruits and seeds, supported by differences in the leaves, calices, androecia, and gynoecia. Distributional patterns, presence or absence of cleistogamy, and the limited cytological and developmental data available all support the recognition of these three groups as separate entities, and at the level of subgenus in agreement with Baker. Section *Clitorianthes* Benth. is thus elevated to the level of subgenus and *Bractearia* is adopted as the oldest and only legitimate name published for this woody group. Bentham's diagnosis of the woody group is modified to include additional characteristics which distinguishes it from the other two subgenera.

CLITORIA L. subgenus **Bractearia** (Mart. ex. Benth.) Fantz, stat. nov.

Clitoria L. sect. *Bractearia* Mart. ex Benth., Ann. Wien. Mus. Natur. 2: 115. 1837.

Trees, tall erect shrubs or treelets, and lianas. Leaves 3-foliolate, long-stalked (petiole 4–16 cm), large (leaflets commonly 8–28 cm long x 3–23 cm wide); petiolules elongate (4–10 cm long). Inflorescence woody, paniculate, subpaniculate or racemose-nodose; usually several- to many-flowered, the flowers all chasmogamous. Calyx subcoriaceous, multi-nerved, persistent in fruit. Ovary elongate (1–2 cm). Staminal tube elongate (2.5–4 cm). Fruits flat or occasionally weakly convex around the seeds and depressed between them, ecostate, long-stipitate (stipe 12–33 mm), coriaceous, 6–25 cm long x 1–4 cm wide. Seeds smooth, compressed, orbicular or nearly so, 7–16 mm in diameter; germination epigeal.

LECTOTYPIC SPECIES: *C. amazonum* Mart. ex Benth. (LECTOTYPE: Brazil, Para, ad fluv. Amazonum prope Ponte de Mattary, Sep, *Martius 2740*, M).

Bentham (1837) placed five species in section *Bractearia* when he first described the group. Of these, *C. amazonum* is designated as the lectotype because it was from the type collection that Bentham obtained the name *Bractearia* Mart. At Munich, six sheets of the type collection (M 12408–12413) are contained in one folder, sheet M 12408 bearing the identification *Bractearia amazonica* Mart. and annotated *Clitoria amazonica* by Bentham.

KEY TO THE SECTIONS OF SUBGENUS BRACTEARIA

1. Bracteoles 6–16 mm wide, coriaceous, 10–40 mm long and subequal to the calyx (it often hidden from view), rarely shorter; inflorescence terminal or axillary (appearing with the leaves), paniculate to subpaniculate, the primary lateral branches which bear the pedicels either short (1–5 mm long) or elongate (to 30 mm long).
   2. Calyx strigulose with scattered, short appressed trichomes, to glabrate, or rarely pilose, its surface easily seen; inflorescence straight to slightly curved, paniculate to subpaniculate, internodal segments ascending in a nearly straight line (non flexuous); trees or occasionally tall erect shrubs, rarely with a climbing apex. . . . . 1. *Bractearia*
   2. Calyx velutinous with short, appressed, more or less silky trichomes, its surface hidden; inflorescence flexuous, at least toward the apex, racemose-nodose, internodal segments weakly to strongly bent in the opposite direction; lianas, occasionally erect shrubs or treelets. . . . . 2. *Flexuosae*
1. Bracteoles 1–4, rarely 6 mm wide, subcoriaceous, usually 2–12 mm long and shorter than the calyx, or rarely elongate and subequal to the calyx, but then always narrow (calyx conspicuous); inflorescence axillary, and then often appearing before the leaves and/or cauliflorous, racemose, the primary lateral branches bearing the pedicels lacking or represented by a conspicuous knob to 1 mm long (=nodose).
   3. Calyx tube 6–13 mm long with minute lobes 1–3 (–5) mm long; legume slightly convexed around the seeds and conspicuously depressed between them at maturity; trees or tall shrub-treelets, rarely lianas. . . . . 3. *Brachycalyx*
   3. Calyx tube 10–30 mm long with conspicuous lobes 4–18 mm long; legume flat, sometimes raised around the seeds but not depressed between them; lianas or rarely shrubs-treelets . . . . . 4. *Cauliflorae*

1. CLITORIA L. subgenus BRACTEARIA (Mart. ex Benth.) Fantz sect. BRACTEARIA

Clitoria L. sect. *Bractearia* Mart. ex Benth., Ann. Wien. Mus. Natur. 2: 115. 1837.
Clitoria L. sect. *Dendrocyamus* Benth., Ann. Ant. Hist. 3: 44. 1839; *nom. superfl.*
Clitoria L. sect. *Clitorianthes* Benth., Journ. Linn. Soc. 2: 41. 1858; *nom. superfl.*

Arbores vel interdum frutices alti. Inflorescentiae paniculatae vel subpaniculatae, lignosae; *rami laterales primarii pedicelliferi (1) 4–30 mm longi*; axes centralis non flexuosus. Calyx pubescentia dispersa vel plerumque glabratus, trichomatibus brevibus, appressis, infrequenter pilosibus. *Bracteolae coriaceae, calycem subaequantes et plerumque occultantes*, 6–16 mm latae et (11–) 14–28 mm longae. *Legumen planum*, coriaceum vel sublignosum, *typice latum, (1.5–) 2–4 cm latum, suturis incrassatis*; pubescentia glabrata plerumque vel trichomatibus microscopicis uncinatis, magnitrichomatibus ribi repertis secus suturas.

Members of section *Bractearia* are commonly collected in forests along the Amazon River and its major tributaries. The section includes seven species (Fantz, 1977): *C. arborea* Hoffm. ex Benth.; *C. amazonum* Mart. ex Benth., *C. fairchildiana* Howard, *C. nervosa* Herz., and three to be described in a succeeding article.

2. CLITORIA L. subgenus BRACTEARIA (Mart. ex Benth.) Fantz sect. **Flexuosae** Fantz, sec. nov.

Frutices lignosi saepius volubiles raro arbores. Inflorescentia debilis vel valde flexuosa prope apicem, segmentis internodiorum abruptly flexuosis, subpanicula; ramis laterales primarii pedicelliferi inconspicuis, subsessilibus ad 6 mm longae. *Calyx pubescentia conferta*, trichomatibus brevibus, appressis, *aliquanto sericeis. Bracteolae coriaceae, calycem subaequantes vel calyce paulo breviores vel raro calyce multo breviores, semper latae factae, (6–) 9–15 mm latae*, 10–40 mm longae. Flores grandes 6–8 (–9.5) cm. *Tubes stamineus elongatus*, 3.5–5 cm longus; antheris grandibus, 2–3 mm longis. *Legumen longistipitatum* (stipes 2.5–4 cm), *planum*, coriaceum, 1.5–2.5 cm latum, pubescentia appressa. Semina brunnea, incrassata, longitudine latitudine longiore.

HOLOTYPIC SPECIES: *C. flexuosa* Fantz[2] (HOLOTYPE: Peru, Tarapoto, Feb. 1856, *Spruce 4527*, K-Hb. Bentham).

Members of section *Flexuosa* have been collected from forest refugia in Peru and Eucador. The section includes three species (Fantz, 1977): *C. flexuosa* Fantz, *C. pozuzoensis* Macbride, and one to be described.

3. CLITORIA L. subgenus BRACTEARIA (Mart. ex Benth.) Fantz sect. **Brachycalyx** Fantz, sect. nov.

Arbores vel frutices alti, raro frutex lignosus saepius volubilis. *Folia decidua, typice tempore florendi, superne puberula*, rarius glabra. Stipulae deciduae vel caducae, lanceolatae, acutae, angustae, 1–2 mm latae. Inflorescentia nodoso-racemosa, axillaris, plerumque primum ad nodos denudato visa praecox. *Calycis tubus brevis, interdum cupulatis (campanulato-tubularis)*, 7–15 mm longus, *lobis late deltoideis minutis vel fere absentibus, 1–4 mm longis*, 3–4 mm latis, latitudo longitudinem subaequalante vel latiore quam longiore. *Bracteolae minutae*, 2–5 mm longae, 1.5–3 mm latae. *Legumen* pubescens, *leniter vel valde depressum inter semina tempore liberationis. Semina* suborbiculata vel leviter longiora quam latiora, compressa, vulgo 7–13 mm diametro, *2–3 mm incrassata.*

HOLOTYPIC SPECIES: *C. brachycalyx* Harms (TYPE: Brazil, Rio Branco, Surumu, camp de Serra de Mairary, Feb 1909, *Ule 8398*, B destroyed during war, photo at MO 1675333; Isotype at K).

Members of section *Brachycalyx* are collected from dry tropical forests or occasionally from open grassy areas of savannas at altitudes up to 900 m,

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[2] CLITORIA **flexuosa** Fantz, sp. nov. A *Clitoria pozuzoensis* Macbride affinis a qua bracteolis et bracteis longioribus, fructibus longo-stipitatis, tubo staminale breviore, petalis brevi-unguiculatis, et foliis plerumque infra subpilosis distinquitur. HOLOTYPE: Peru, Tarapoto. Frutex volubili robustus, flores rosei, Feb 1856, *Spruce 4527* (K-Hb. Bentham). ISOTYPES: K-Hb. Hooker, W 18669. PARATYPES: Tarapoto, *Spruce s.n.* (K); Peru, San Martín, Juan Jui, Alto Río Huallaga, ca. 400 m, Sep 1934, *Klug 3820* (BM,F 766344,GH, MO 1105520 & 1105521).

in northwestern South America and adjacent Panama. Isolated collections of one species have been made as far north as Chiapas, Mexico. The section includes seven species (Fantz, 1977): *C. brachycalyx* Harms, *C. brachystegia* Benth., *C. dendrina* Pittier, *C. glaberrima* Pittier, and three to be described.

4. CLITORIA L. subgenus BRACTEARIA (Mart. ex Benth.) Fantz sect. **Cauliflorae** Fantz, sect. nov.

Frutices lignosi saepius volubilis vel infrequenter frutices erecti. Inflorescentia vulgo cauliflora et axillaris, racemosa, plus minusve nodosa. *Bracteolae* amplitudine variae, sed non grandae et calycem occultantes, *typice calycis tubo breviores et angustae*, 1–3 (raro –6) mm latae. *Calycis tubus lobos conspicuos ferens*, typice 4–13 (–27) mm longos. Legumen planum vel leniter depressum inter semina, pubescentia typice microuncinata cum macrotrichomatibus dispersis, effusis vel suberectis, interdum confertis cum trichomatibus uncinatis nullis. *Semina* vulgo suborbiculata, raro oblonga, *3–5 mm incrassata*, interdum compressa.

HOLOTYPIC SPECIES: *C. sagotii* Fantz[3] (HOLOTYPE: French Guiana, Karouany, 1857, *Sagot 120*, K-Hb. Bentham).

Members of section *Cauliflorae* are found mostly in northern South America, one extending into Central America. The section includes twelve species (Fantz, 1977): *C. arborescens* R. Brown in Ait., *C. coriacea* Schery, *C. javitensis* (H.B.K.) Benth., *C. leptostachya* Benth., *C. obidensis* Huber, *C. sagotii* Fantz, *C. selloi* Benth., and five to be described.

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[3] CLITORIA **sagotii** Fantz, sp. nov. A *Clitoria javitensis* (H.B.K.) Benth. affinis a qua calycis, leguminis, et ovarii trichomatibus prominentibus uncinatis pagina supra folii medionervum elevatum ferenti, inflorescentia subsessile, vexillo brevi-unguiculato, stylo ovario multo longiore et fructibus parvioribus, semina incrassatis distinguitur. HOLOTYPE: Fr. Guiana, Karouany, 1857, *Sagot 120* (K-Hb. Bentham, photo at S). ISOTYPES: GH,NY,S,U 37632A,W.

NEW SPECIES OF *CLITORIA* SUBGENUS *BRACTEARIA* SECTION *BRACTEARIA* (LEGUMINOSAE) FROM PERU AND ECUADOR[1]

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Members of *Clitoria* L. subgenus *Bractearia* (Mart. ex Benth.) Fantz section *Bractearia* are distinguished by the large coriaceous bracteoles which subequal and obscure the sparsely pubescent to glabrate calyx, (sub-) paniculate inflorescences in which the pair of pedicels are borne at the apex of the primary lateral branches, broad thick-sutured fruits, and by the tall, erect, woody habit (trees or shrubs commonly 5–30 m tall). Section *Bractearia* includes seven species (Fantz, 1977): *C. arborea* Hoffm. ex Benth., *C. fairchildiana* Howard, *C. amazonum* Mart. ex Benth., *C. nervosa* Herz., and three newly described below.

1. CLITORIA **juninensis** Fantz, sp. nov.

Frutex 2–4 m altus. *Folia* trifoliolata *subtus subvelutina; foliola obtusa, acumine brevi*, 1–7 mm longo. *Stipulae deciduae, 8–11 mm longae*; stipellae 5–10 mm longae. Inflorescentiae subpaniculato-racemosae, axillares et terminales, multiflorae; rami laterales primarii pedicelliferi subsessiles ad 5 (–8) mm longi. *Bracteolae amplae*, coriaceae, oblongo-ellipticae, calycem subaequantes, *14–18 (–20) mm longae*. Flores 4–5.5 cm; vexillum extus fluvum, sericeum. Stylus 16–17 mm longae. Legumen stipitatum, planum, glabrum, sutura incrassata. Semina fere orbiculata, anthracina, compressa, laevis.

Shrub, erect, 2–4 m tall. Branches elongated (vide *Killip & Smith 23380*), hollow, to 10 mm thick, juvenile branches subangular with dense, spreading, rufus trichomes, branches becoming terete and seemingly glabrate, with uncinate trichomes becoming more conspicuous (observe at 30X); bark dark brown, splitting in longitudinal strips, lightened beneath; axillary buds 1–2 mm, scales glabrate. *Leaves* 3-foliolate, coriaceous, leaflets broadly elliptic, ovate-elliptic, or obovate, apex generally obtuse, rapidly narrowed to a short acumen of 1–7 mm, more or less mucronate, base broadly cuneate to rotund, midrib impressed above, glabrous or bearing short erect and/or uncinate trichomes, primary nerves of 10–16 (–18) pairs, upper surface dark green and glabrous, lower surface pale green and subvelutinous, lamina 8–22 cm long, 4–9 (–12.5) cm wide. Petioles subangular-terete, 4–11 cm ribbed, with moderately dense, spreading, short, rufus trichomes; rachis more com-

[1] Taxonomic studies on *Clitoria* accomplished at the IFAS Herbarium. Dept. of Botany, University of Florida, Gainesville, Florida. Florida Agricultural Experiment Station Journal Series No. 1345.

pressed, (1.5–) 2–3.5 cm; petiolule subquadrangular, 6–10 mm, with dense, spreading, rufus trichomes. Stipules deciduous, lanceolate-deltoid, acute, 8–11 mm long, 2–3 mm wide; stipels more persistent, linear, acute, 5–10 mm long, 0.2–0.7 mm wide. Inflorescence subpaniculate-racemose, axillary and terminal, solitary, multiflowered, pubescence dense, trichomes short, spreading, rufus; central axis 5–23 cm long, lignose and nodose in fruiting stage, the primary

Figure 1. Holotype of *Clitoria juninensis* (*Killip & Smith 23380*, NY).

lateral branches which bear the pedicels subsessile to 5 (–8) mm long; pedicels paired, 4–7 mm. Bracts ovate, acute, reflexed in age, 4–7 mm long, 2–3 mm wide, pubescence dense, trichomes appressed, rufus. Bracteoles large, coriaceous, oblong-elliptic, subequal to calyx, 14–18 (–20) mm long, 7–10 mm wide, pubescence appressed. *Flowers* all chasmogamous, 4–5.5 cm, white to pink with a bluish-tinge. Calyx sparsely pubescent, trichomes appressed, tube 13–17 mm long, 3–5 mm wide at the base expanding to 8–12 mm wide at the throat, lobes ovate-deltoid, acuminate, 5–7 mm long, 3–4 mm wide, ventral lobe narrow, 7–8 mm long. Vexillum pubescence dense, trichomes appressed, tawny, blade 3–3.5 cm wide, claw 8–9 mm. Alae white to pinkish, extending 6–8 mm beyond the carina, blade 18–23 mm long, 5–9 mm wide, claw 13–15 mm. Carina bluish, falcate, blade 9–13 mm long, 4 mm wide, claw 24–27 mm. Staminal tube glabrous, 27–32 mm long, free filaments 3–5 mm long; anthers 1.5–1.7 mm long, 0.5–0.8 mm wide. Gynophore 3 mm; ovary ca. 14 mm long, 1.2 mm wide, pubescence dense, trichomes appressed, yellowish-white; style bearded, 16–17 mm long, geniculate 6–7 mm; stigma flattened, 1 mm diam. *Legume* stipitate, slightly exerted beyond calyx, greenish-brown, flat, coriaceous, glabrous, thick-sutured, 21 cm long, 2.5–3.2 cm wide; stipe 14–17 mm; beak to 4 mm; dehiscence causing valves to twist one-half of a turn. Seeds nearly orbicular, black, smooth, compressed, 1–2 mm thick, ca. 10 mm long, 9 mm wide; 7 seeds per pod. Fig. 1.

TYPE COLLECTIONS: Perú. Shrub, 8–12 ft., with elongated branches; standard and wings white, blue-tinged, keel blue, white proximally, La Merced, Dept. Junín, 700 m, 29 May-4 Jun 1929 *Killip & Smith 23380* (HOLOTYPE: NY. ISOTYPES: F 616214, US 1358082). PARATYPES: Clearing along Río Perené near "Hacienda 3", Colonia Perene, 600 m, *Killip & Smith 25136* (NY); Pampa Whaley, Colonia Perené, prov. Tarma, 700–750 m, 14 Feb 1959, *Ferreyra 13555* (WIS-2 sheets).

Clitoria juninensis has close affinities with *Clitoria andrei* which is distinguished by the elongated acumens of the leaflets, shorter stipules and stipels, somewhat smaller flowers with larger bracteoles, a nonsericeous vexillum, and by the tree habit. All known collections of *C. juninensis* occur from the Dept. of Junin, Peru, where the species is an apparent endemic of highland scrub communities at elevations of 600–2000 m.

2. CLITORIA **andrei** Fantz, sp. nov.

Arbor ad 20 m alta. *Folia* trifoliolata *subtus subvelutina, foliolis abrupte acuminatis, acumine elongato*, 1–2 cm longo. *Stipulae caducae, 4 mm longae*; stipellae breves, 2–5 mm longo. *Inflorescentiae elongatae*, subpaniculato-racemosae, axillares et terminales, multiflorae; rami primarii laterales pedicelliferi subsessiles ad 2 mm longi. *Bracteolae amplae*, coriaceae, oblongae, obtusae, calycem subaequantes, *22–25 mm longae*. Flores 4–4.5 cm; *vexillum extus fulvum, cum trichomatibus secus nervos*. Stylus 17–21 mm. Legumen ignotum.

Tree to 20 m tall. Branches subquadrangular becoming terete, to 1 mm diam., hollow, juvenile branches with short appressed to spreading trichomes, becoming glabrate; bark light brown; axillary buds 1.5–2 mm, bud scales

ovate, acute, concave, strigose. *Leaves* 3-foliolate, coriaceous, leaflets ovate-lanceolate to elliptic lanceolate, apex abruptly acuminate, acumen 1–2 cm, mucronate, base broadly cuneate to rotund, midrib impressed to subimpressed above, often bearing short erect trichomes, primary nerves 13–17 pairs, upper surface dark green, glabrous, lower surface pale green, subvelutinous, lamina 7–20 cm long, 3–8 cm wide. Petiole subangular-terete to compressed

Figure 2. Holotype of *Clitoria andrei* (*Andre 4675*, GH).

above, 4–7 cm, pubescence of short, spreading trichomes; rachis subquadrangular, 1–2.5 cm; petiolules quadrangular, 6–7 mm, trichomes falcate. Stipules caducous, deltoid, acute, 4 mm long, 3 mm wide; stipels deciduous, linear, 2–5 mm long. *Inflorescence* elongate, subpaniculate-racemose, axillary and terminal, solitary, multiflowered, pubescence of axes dense, trichomes short, erect, rufus on juvenile portions becoming less dense and whitened with age; central axis 7–20 cm long, the primary branches which bear the pedicels subsessile to 2 mm long; pedicels paired, 6–8 mm. Bracts ovate, acute, reflexed in age, 4–6 mm long, 1.5–2 mm wide, pubescence dense, trichomes rufus. Bracteoles large, coriaceous, oblong, obtuse, subequal to calyx, 22–25 mm long, 9–12 mm wide, pubescence strigose. *Flowers* resupinate, all chasmogamous, pink with bluish tinge, 4–4.5 cm. Calyx pubescence sparse, trichomes short, appressed, tube infundibular, 14–16 mm long, 4–5 mm wide at the base expanding to 9–11 mm wide at throat, lobes deltoid, 5–7 mm long, 2–3 mm wide, ventral lobe 6–8 mm long. Vexillum indumentum of short, appressed, tawny trichomes confined primarily along the nerves, blade 2.5–3 cm wide, claw ca. 12 mm. Alae extended 6–8 mm beyond the carina, blade ca. 16–18 mm long, 4–6 mm wide, claw ca. 15–17 mm. Carina falcate, blade ca. 9 mm long, 3–4 mm wide, claw ca. 24–27 mm. Staminal tube sparsely pubescent near apex, trichomes microscopic (observe 30X), uncinate, tube 28–30 mm long, free filaments 2–3 mm long, uncinate-trichomed; anthers 1.5–2 mm long, ca. 0.3 mm wide, connective apiculate. Gynophore 3 mm; ovary ca. 14 mm long, 1.3 mm wide, pubescence dense, trichomes yellowish-white; style 17–21 mm, bearded, geniculate 6–7 mm; stigma discoid, 0.5 mm diam. *Legume* unknown. Fig. 2.

TYPE COLLECTIONS: Ecuador. Inter Guayaquil and Santa Rosa, 60 m, July 1876, *Andre 4675* (HOLOTYPE: GH. ISOTYPES: F 537681, K, NY).

Clitoria andrei has close affinities with *Clitoria juninensis* of Peru which is distinguished by the obtuse leaflets with a minute acumen, larger stipules and stipels which are more persistent, smaller bracteoles on somewhat larger flowers, a sericeous vexillum, and by the shrubby habit. The species is known only from its type locality in Ecuador.

3. CLITORIA **moyobambensis** Fantz, sp. nov.

Arbor. Folia trifoliolata *subtus glabrescentia*, foliolis acuminatis, acumine elongato, 1.5–3 cm longo. *Stipulae amplae*, concavae, 10–12 mm longae, *4–6 mm latae*; stipellae caducae. Inborescentiae axillares et terminales, subpaniculato-racemosae, multiflorae; rami laterales primarii pedicelliferi subsessiles ad 2 mm longi. *Bracteae amplae*, coriaceae, lanceolatae, breviacuminatae, *8–11 mm longae, 3–5 mm latae. Bracteolae* amplae, coriaceae, oblongo-ellipticae, calycem subaequantes, obtusae vel abrupte apiculatae, *12–15 mm longae.* Flores 4–5 cm; vexillum extus fulvo-sericeum. *Stylus brevis, 14 mm longo.* Legumen ignotum.

Tree. Branches hollow, 4–7 mm diam., juvenile branches subquadrangular, longitudinally striated and sulcate, grooves shallow to deep, pubescence

prominent, trichomes uncinate (observe 30X) and short, falcate to appressed (conspicuous at 10X), branches becoming subterete and glabrous with age; bark medium gray, splitting into longitudinal strips, whitish-tan beneath. *Leaves* 3-foliolate, coriaceous, leaflets elliptic-lanceolate, tapering to acuminate apex, acumen 1.5–3 cm long, to 1.2 cm wide at broadly cuneate base, mid-

Figure 3. Holotype of *Clitoria moyobambensis* (*Mathews s.n.*, K-Hb. Hooker).

rib impressed above bearing uncinate trichomes, primary nerves 13–16 pairs, upper surface dark green, glabrous or with short trichomes along major nerves, lower surface light green, glabrous, lamina 12–15.5 cm long, 6–8 cm wide. Petioles conspicuously twisted at base, longitudinally striated and canaliculate, 4–5 cm long, pubescence scattered, trichomes minute, falcate to appressed; rachis similar, 4 cm; petiolules quadrangular, rugose, 8–9 mm. Stipules large, conspicuous, concave nearly halfway around stem, lanceolate-ovate, rapidly tapering above middle to acute apex, 10–12 mm long, 4–6 mm wide; stipels caducous, only one terminal stipel observed (2 mm x 0.4 mm). *Inflorescence* axillary and terminal, solitary, subpaniculate-racemose, multi-flowered, trichomes subappressed; central axis twisting, longitudinally striated and caniculate, to 4 cm long (juvenile?), primary lateral branches which bear the pedicels subsessile, 1 (–2) mm long; pedicels paired, 8–14 mm. Bracts large, conspicuous, lanceolate, short-acuminate, 8–11 mm long, 3–5 mm wide, trichomes appressed. Bracteoles large, coriaceous, multinerved, oblong-elliptic, obtuse or abruptly apiculate, subequal to calyx, 12–15 mm long, 9–10 mm wide, pubescence ciliolate and strigose. *Flowers* resupinate, all chasmogamous, 4–5 cm. Calyx infundibular, glabrate, trichomes widely scattered, appressed, tube inconspicuously multinerved, nerves subimpressed, 13–15 mm long, 4–6 mm wide at the base expanding to 8–10 mm wide at throat, lobes deltoid, acute, 5–6 mm long, 4 mm wide, ventral lobe 7 mm long. 2 mm wide. Vexillum tawny-sericeous, blade 3–4 cm wide, claw 11 mm. Alae and carina hidden by vexillum and/or damage, not clearly observed. Staminal tube glabrous, 27–28 mm long, free filaments 1–3 mm long; anthers 0.8 mm long, 0.5 mm wide. Gynophore ca. 5 mm; ovary 13 mm long, 1 mm wide, lateral surfaces densely pubescent, trichomes uncinate, sutural edges with 1 mm long, ascending trichomes; style 14 mm long, bearded, geniculate 6 mm; stigma dark, ca. 0.7 mm diam. with a ring of short, reflexed trichomes at its base. *Legume* unknown. Fig. 3.

TYPE COLLECTION: Perú. Prov. Moyobamba, 1838. *Matthews s.n.* (HOLOTYPE: K-Hb. Hooker).

Clitoria moyobambensis is easily distinguished from other species in the subgenus by the unusually large bracts and stipules, and the pubescence of the ovary, a type unique amongst those species with a tree habit. This species appears to have close affinities with *Clitoria juninensis* and *Clitoria andrei* which have similar floral structures. It is known only from the type locality.

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FLORISTIC AND GEOLOGIC ASPECTS OF INDIAN MIDDENS IN SALT MARSHES OF HANCOCK COUNTY, MISSISSIPPI

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ABSTRACT

Sixty-two species of flowering plants were collected from Indian middens (shell mounds) located in the salt marshes of Hancock Co., Miss. The diversity of the flora depended on the height of the midden above the marsh surface and increased with increased elevation. The largest midden (Cedar Island), with an elevation of about 1 m above the surface of the marsh (about 1.3 m above MLW) had the greatest diversity of species (47). Radiocarbon dating indicates that clam shells (*Rangia cuneata*) found on the surface of Cedar Island are over 2,600 years old. The geological history surrounding the establishment of the middens is discussed. Indicator plants for these Indian occupation sites 0.5 m or more above MLW are the calciphiles *Juniperus silicola*, *Erythrina herbacea*, and *Aesculus pavia*. These shell middens provide the only known habitat of *Sageretia minutiflora*, the first report of its occurrence in Mississippi.

INTRODUCTION

Salt marshes were apparently utilized by prehistoric humans for a considerable length of time. Human occupation sites in the coastal areas of Louisiana were established as early as 12,000 B.P. (Gagliano, 1963). Presently known cultural sites on the Mississippi Coast date back only to the last four millenia. The fact that these early people gathered shellfish as a food item from the estuarine waters and salt marshes is evident by the presence of numerous and extensive shell mounds, composed of the clam *Rangia cuneata*. Such shell deposits are "kitchen middens" (refuse heaps) at periodic Indian occupation sites, located close to the source of food. These mounds are relatively enduring features in the changing coastal environment and represent the only remaining local sites of floristic disturbance by prehistoric man, not obscured by natural processes or European man. Over the past several years we have located five previously unreported and undisturbed shell middens in the salt marshes of Hancock County, Mississippi. Although Brown (1936) described the vegetation of 16 mounds and middens in Plaquemines and St. Bernard Parishes (delta areas of the Mississippi River),

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Louisiana, on the shell middens we have visited, we noted an array of plant species previously unreported in Louisiana or Mississippi. The geological conditions that relate to the establishment of these middens are essential for the understanding of the flora's development. The present paper is the result of a combined effort to study these middens floristically and geologically.

The middens can only be reached by boat or pontooned helicopter. This isolation probably contributed to their preservation. A study of aerial photographs indicated the location of suspected shell middens and was followed by a general survey of the salt marsh area where five middens in the tidal marsh east of the Pearl River and south of Cadet Bayou were selected for study (Fig. 1). Floristic surveys were conducted seasonally in 1974, and periodically in 1975, 1976, and 1977. Geological information was taken from an ongoing, detailed geological study of the Mississippi coast including core drillings in the marshland and radiocarbon dating of the middens.

GEOLOGICAL FRAMEWORK

The geological evolution of southern Hancock County (Fig. 1) began after a long period during the Wisconsin glacial stage and the early Holocene epoch when the subject area was dry land. Transgressing mid-Holocene sea waters reached it at about 6,300–6,000 years ago. By about 4,000–3,500 years ago, all of the present marsh area was inundated and a low dune ridge (Magnolia Ridge) formed along this new shoreline. With the first arrival of sea waters, silty-muddy and marsh deposits characterized by *Ammotium-Haplophragmoides-Miliammina* agglutinate foraminifers, formed in the low salinity nearshore waters influenced by fresh waters from the Pearl River. Oyster reefs developed in more saline waters further seaward, while the central and southern-southeastern parts of the present marsh area were covered by the highest salinity waters. Open-Gulf nearshore-type, varied and rich foraminifer fauna (*Elphidium-Buliminella-Nonion-Ammonia*) thrived on the bottom sediments there (Fig. 2). The high energy conditions near the shore resulted in the development of sandy shoals and in the subsequent emergence of low (1.5–4.0 m), narrow, elongated barrier islands: Point Clear and Campbell Islands.

The sand for these developing islands was derived from the east along the Mississippi barrier island-shoal chain (via Cat Island—Square Handkerchief Shoal) and the Hancock barrier islands themselves become parts of another 50 km long barrier-shoal trend (Bayou Sauvage—Hancock County trend, Otvos 1973, Fig. 16) which extended deeply into the present New Orleans area. Growth of the large Mississippi River subdeltas (St. Bernard Parish) prevented further seaward progradation of Point Clear and Campbell Islands. This delta development south-southeast of the Hancock area eventually cut off the sand supply. It severely restricted open marine water influx and also reduced wave energies. The decreasing salinities south of the two

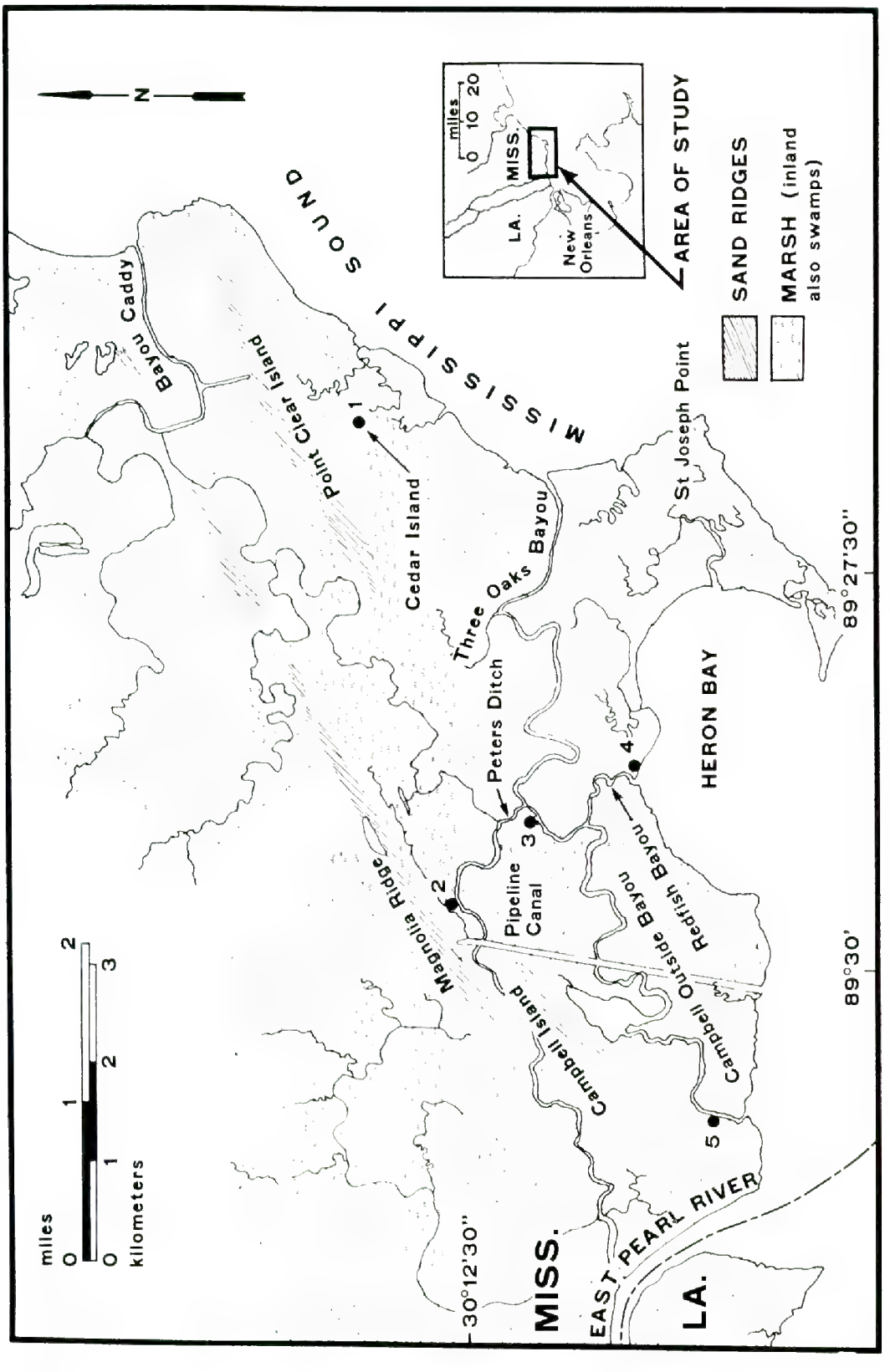


Figure 1. South Hancock County marshland. Numbers 1–5 refer to Indian midden locations, discussed in text.

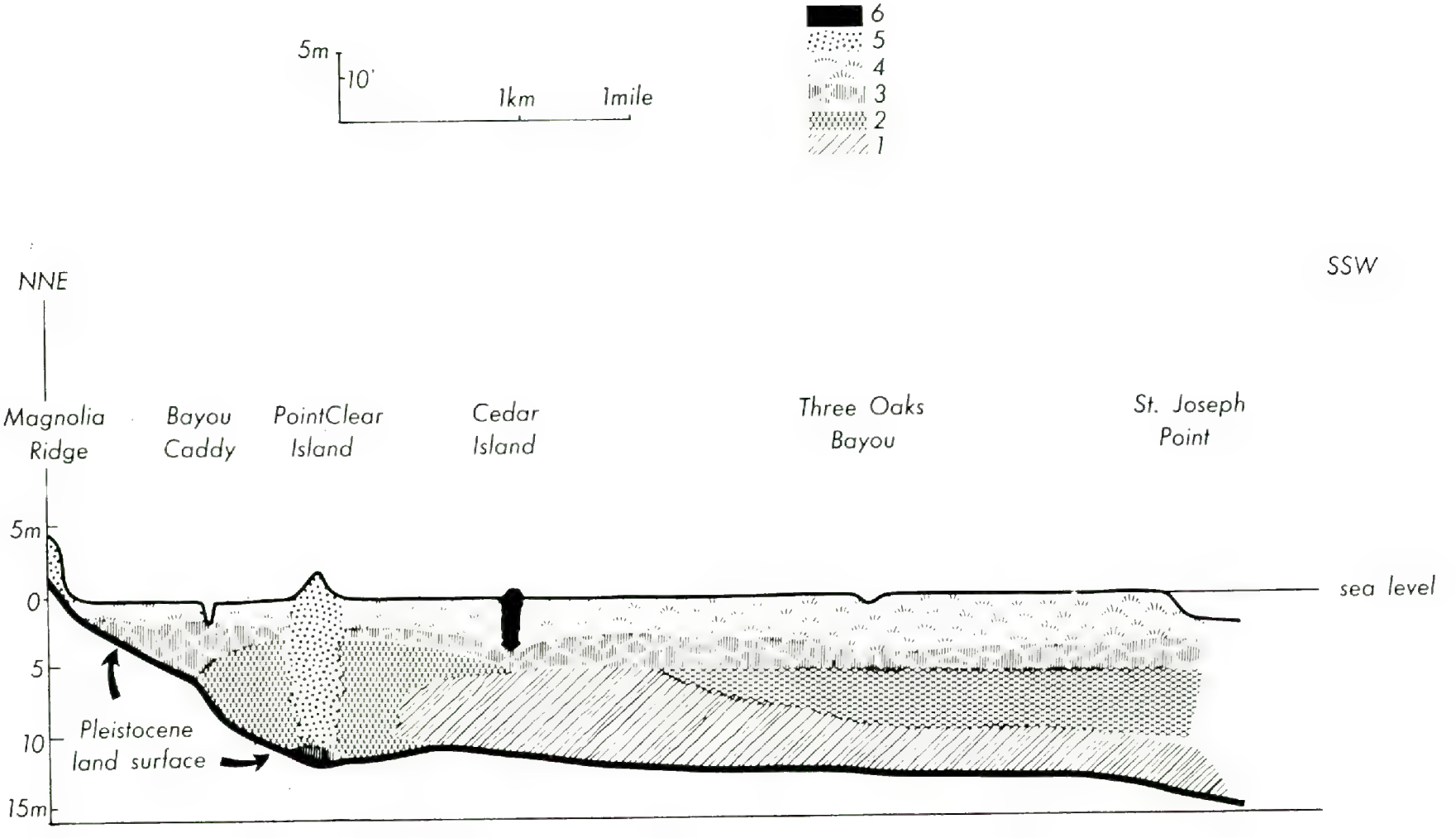
islands are reflected by the less varied *Ammonia-Elphidium-Nonion-Nonionella* fauna in the muddy, sandy-muddy nearshore deposits of the period. Immediately south of Campbell and Point Clear Islands, sediments, presumably mostly from the Pearl River, built the bottoms up to intertidal levels and marsh vegetation was established, protected by the Mississippi River subdeltas. At its peak of development, this marshland extended considerably beyond the present southern and eastern marsh shores.

At this stage, Indian refuse middens started to dot the banks of creeks in the newly established marshland. Shells of a very low salinity bivalve, the edible *Rangia cuneata* almost exclusively form the mounds. This is especially so, at the largest midden, "Cedar Lsland". Some of the other middens also contained lesser quantities of oyster shells (*Crassostrea virginica*) and the snail (*Littorina irrorata*). "Cedar Island", with a surface area of 50 by 150 m (Fig. 1, Site 1), extends about 1.0 m above mean sea level and, according to borings, to about 3.5 m below sea level. Most of the mounds were formed during the Tchefuncte and later cultural periods, characterized by pottery production (Table 1). Each mound represents long periods of intermittent occupation and shell accumulation during seasons of food gathering activities. Subsidence, caused mostly by the compaction of the underlying muddy Holocene sediments, clearly affects the mounds. This is shown by occasional, partially drowned oak trees and red cedars in the marsh along mound peripheries. Due to subsidence, some middens may have been completely buried under surface deposits.

Marsh accretion ended between 2,000–1,700 years ago. Termination of the active flow through the protective Mississippi-St. Bernard subdeltas started their disintegration. Renewed coastal erosion increased the adjoining western Mississippi Sound water area and the strength of erosive wave energy on the shores. This initiated the present steady reduction of the south Hancock marshland area.

Table 1. Radiocarbon dates of *Rangia cuneata* from Indian shell mounds, Hancock County salt marshes.

Site (Fig. 1)	Dating laboratory	No. of Analysis	Date (yrs. B.P.)
1 (Cedar Island)	University of Georgia, Geochronology Lab.	UGa-353	2650±70
		UGa-354	2900±70
2	Krueger Enterprises	GX2653	1295±90
3	University of Georgia, Geochronology Lab.	UGa-371	2680±75
4	University of Georgia, Geochronology Lab.	UGa-373	2035±65
5	Krueger Enterprises	GX25671	1190±110


5m
10'
1km
1mile
6
5
4
3
2
1
NNE
SSW
Magnolia Ridge
Bayou Caddy
PointClear Island
Cedar Island
Three Oaks Bayou
St. Joseph Point
5m
0
5
10
15m
sea level
Pleistocene land surface

BOTANICAL ASPECTS

COMPOSITION AND DISTRIBUTION.

The vegetation of the Indian middens contrasts conspicuously with the low profile, homogeneous, and rather monotonous vegetation of the surrounding, extensive salt marshes. A list of plants found on the middens is shown in Table 2. The marshes are composed primarily of *Juncus roemerianus, Spartina alterniflora,* and *Distichlis spicata* (Eleuterius, 1972). The most abundant trees on the middens are the live oak (*Quercus nigra*) and the southern cedar (*Juniperus silicola*). The prevalence of cedar on the largest midden studied is apparently the basis for its name (Cedar Island; USGS Quadrangle, Grand Island Pass, Miss.-La., 1956, photorevised, 1970). Here 16 oaks with diameters at breast height (DBH) ranging from 6–62 cm and about 50 cedars, the largest with a 45 cm DBH. Other common trees found were *Celtis laevigata, Diospyros virginiana, Morus rubra* and *Zanthoxylum clava-herculis.*

The understory of site 1, "Cedar Island" is composed of a mixture of shrubs, primarily *Yucca aloifolia* and herbs. This midden, the most diverse floristically, contained a dense vegetational cover forming an almost impenetrable mass. Other shrubs of frequent occurrence on the top of the middens were: *Ilex vomitoria, Sabal palmetto, Sambucus canadensis, Hypericum hypericoides, Rhus copallina, Erythrina herbacea, Aesculus pavia,* and *Sageretia minutiflora.*

There is no obvious zonation of plants on the midden and the general impression is one of over-crowding. Numerous trees and shrubs lean outward from the mound, this "overhang" shading much adjacent marsh. Many of the shrubs are quite tall and often reach about 6 m. One large oak blown down by winds of Hurricane Camille in the east-central island area in 1969 left a large opening that subsequently was invaded by *Yucca aloifolia.* The southeastern portion of Cedar Island presently is vegetated primarily by small trees, shrubs, and herbs. Stumps indicate that larger trees grew here in the past. The prevailing southeasterly winds apparently have an effect on the vegetation here, sculpturing and damaging the vegetation, as on the eastern ends of the offshore barrier islands (Eleuterius, 1975; Penfound and O'Neil, 1934; Lloyd and Tracey, 1901; and Miller and Jones, 1967). The periphery of the midden contained shrubs that are common on natural levees along the bayous, upland edges of salt marshes and dredged soil. There were *Baccharis halimifolia, Iva frutescens, Borrichia frutescens,* and *Myrica cerifera.*

Figure 2. Geological cross section through Holocene deposits in southern Hancock County marshland. Symbols: 1–clay, mud, sandy mud with *Elphidium-Buliminella* fauna (highest salinity deposits); 2–clay, mud, sandy clay and mud with *Ammonia-Elphidium-Nonion* fauna (reduced salinity); 3–muddy sand, sandy mud, mud with *Ammotium-Haplophragmoides-Miliammina* fauna (low salinity; 4–salt marsh deposits; 5–dune and barrier ridge sands; 6–Indian cultural accumulation (shell mound).

Table 2. Plant species found on Indian middens in Hancock County marshes. Indicator species are those found on shell middens and not in the marshes. They are marked with an asterisk.

Scientific Names	Common Names
TREES	
Celtis laevigata Willd.	Hackberry
Diospyros virginiana L.	Persimmon
**Gleditsia triacanthos* L.	Honey Locust
**Juniperus silicola* (Small) Bailey	Southern Red Cedar
Morus rubra L.	Red Mulberry
Quercus virginiana Miller	Live Oak
**Zanthoxylum clava-herculis* L.	Hercules-Club, Prickly Ash
SHRUBS AND WOODY VINES	
**Aesculus pavia* L.	Red Buckeye
**Ampelopsis arborea* (L.) Koehne	Pepper-Vine
Baccharis halimifolia L.	Groundsel-Tree
Borrichia frutescens (L.) DC.	Sea Ox-eye
**Bumelia lanuginosa* (Michaux) (Pers.)	False Buckthorn, Chittumwood
Campsis radicans (L.) Seemann	Trumpet Vine
**Cissus incisa* (Nutt.) Des Moulins	Marine ivy, Marine vine
Cocculus carolinus (L.) DC.	Coralbeads
**Erythrina herbacea* L.	Coral Bean
Hypericum hypericoides (L.) Crantz	St. Andrew's Cross
Ilex vomitoria Aiton	Yaupon
Iva frutescens L.	Marsh Elder
**Matelea caroliniensis* (Chapman) Woodson	Spiny Pod Milkweed, Climbing or Vining Milkweed
Myrica cerifera L.	Wax Myrtle
Rhus copallina L.	Dwarf or Winged Sumac
Sabal palmetto Lodd. ex Schultes	Cabbage Palmetto
**Sageretia minutiflora* (Michaux) Trel.	Buckthorn
Sambucus canadensis L.	Elderberry
Serenoa repens (Bartram) Small	Saw Palmetto
Similax bona-nox L.	Greenbrier
Wisteria frutescens (L.) Poiret	Wisteria
**Yucca aloifolia* L.	Spanish Bayonet, Yucca
HERBS	
Amaranthus spinosus L.	Thorny Amaranth
Ambrosia artemisiifolia L.	Ragweed
Chaerophyllum tainturieri Hooker	Wild Chervil
Cuscuta pentagona Engelm.	Dodder
**Elymus virginicus* (L.) Britton	Wild Rye grass
Erigeron philadelphicus L.	Daisy Fleabane
Eryngium yuccifolium Michaux	Button Snakeroot
Eupatorium serotinum Michaux	Thoroughwort
Euphorbia maculata L.	Forb
Ipomoea sagittata Cav.	Morning Glory
Lepidium virginicum L.	Poor-mans Pepper
Manisuris rugosa (Nuttall) Kuntze	Joint Grass

Opuntia compressa (Salisbury) Macbride	Prickly Pear
Opuntia stricta Haw.	Prickly Pear
Oxalis dillenii Jacquin	Wood Sorrel, Sheep Sorrel
Panicum amarum Ell.	Bitter Panicum, Beach Grass
Panicum virgatum L.	Switch Grass
Passiflora lutea L.	Passion-flower
Phragmites communis Trinius	Common Reed, Roseo Cane
Physalis angustifolia Nutt.	Ground Cherry
Phytolacca rigida Small	Poke, Pokeberry, Pokeweed
Rhus radicans L.	Poison Ivy
Samolus parviflorus Raf.	Water Pimpernel
Scutellaria ovata Hill	Skullcap
Solidago sempervirens L.	Goldenrod
Spartina cynosuroides (L.) Roth	Hog Cane
Spartina spartinae (Trin) Merrill	Clumped Cord Grass
Specularia perfoliata (L.) A. DC.	Venus Looking-Glass
Stellaria media Cyrillo	Chickweed
Tillandsia usneoides L.	Spanish Moss
Verbesina occidentalis (L.) Walter	Crown Beard
Verbesina virginica L.	Coffee Bean
Vicia ludoviciana Nutt.	Vetch, Deer Pea

There were also many woody vines on the middens such as: *Cissus incisa, Wisteria frutescens, Ampelopsis arborea, Smilax bona-nox Cocculus carolinus, Campsis radicans,* and *Rhus radicans.*

ELEVATION-TIDE RELATIONS. All the other middens are of relatively low profile, and less than one meter in elevation. The diversity of the herbaceous flora is reduced (Fig. 3) with reduced elevation. Those middens only slightly above the surface of the marsh (0.1 m above MLW) had fewer species than those on more elevated areas. No tree species were found below 0.5 m elevation (above MLW). Locally tidal amplitude is about 0.3–0.5 m, thus tidal inundation is probably responsible for the reduction of species.

PLANT-SOIL RELATIONSHIPS. Although the soil on the middens is generally thin, a very black soil layer 4–8 cm thick is often found and is apparently nutritionally rich, judging from the dense vegetation supported. Roots apparently rework soil and shell; shell and soil were found mixed at 8–16 cm depth. Although high phosphorous content of soils is characteristic of upland Indian habitation sites (Diety, 1957; Zeiner, 1946), available phosphorous was generally low, probably due to the relatively high pH of the soil (Hole and Heizer, 1965).

RARE SPECIES. *Sageretia minutiflora*: Mohr (1901) indicated the distribution of *Sageretia minutiflora* as extending from the Carolinas to Florida and west to Mississippi. Recent floristic surveys have failed to locate this species on the coastal plain of Mississippi and Alabama. Radford et al. (1968)

state that it occurs in only two coastal counties of South Carolina and in one in Georgia. Long and Lakela (1971) reported it from Lee County, Florida and Clark (1971) from Mobile Co., Alabama. Specimens were taken from a large shell midden on Dauphin Island. Michael Lelong (personal communication) collected the species from clam shell middens on Little Dauphin Island, Alabama. Shell middens apparently provide the only habitat for this species and this is the first report of its presence in Mississippi.

CULTURED RELATIONSHIPS. Several of the plant species apparently had cultural relationships with prehistoric man since identifiable plant parts have been found in burial mounds (personal communication, Dale Greenwell). Seeds of plants of economic value may have been purposefully introduced at the semi-permanent occupation sites. Cedars may have been propagated because of the fine tinder produced from the bark and used in fire making. Coral bean seeds were probably a source of pigment for paint and used as "bead" ornaments. The fruits of the buckeye are historically known (at least locally, from pioneer days) to make a powerful fish poison. *Manisurus rugosa* consistently found on the more elevated sites is cited by Mangledorf (1974) as an ancestor of modern corn *Zea mays*. There is no known basis for extend-

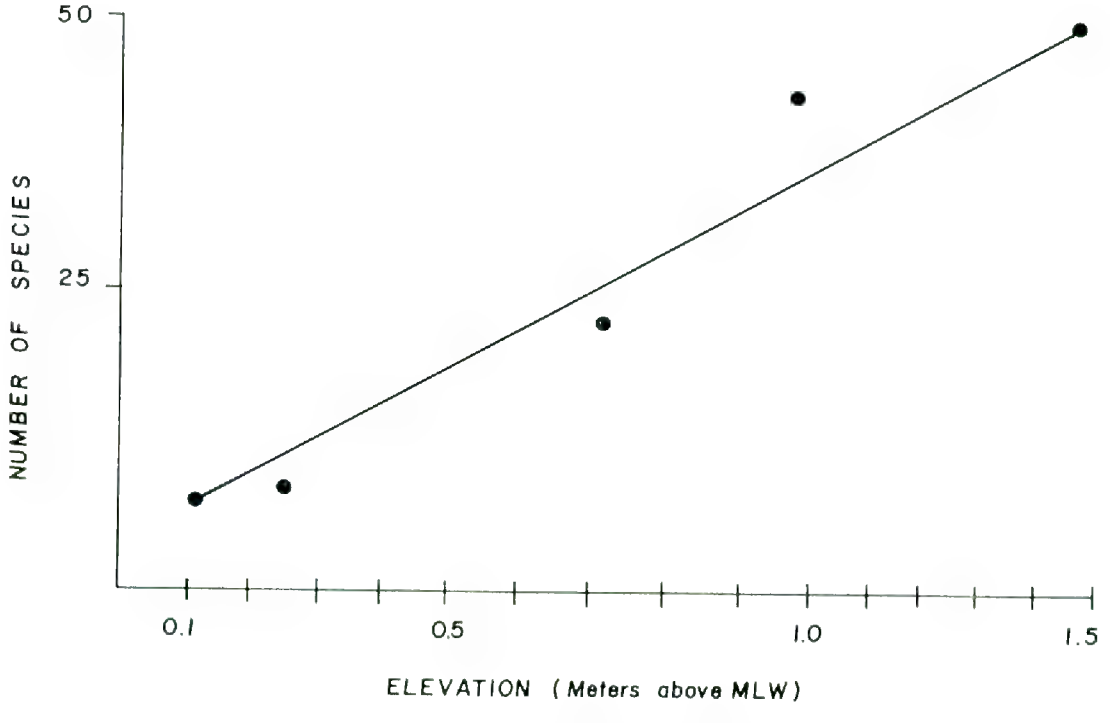


Figure 3. Species diversity in relation to the elevation of Indian clam shell middens in the marshes of Hancock Co., Miss. The number of plant species increased with an increase in elevation. (MLW = mean low water).

ing such speculation to the other species. Chemical work (pharmaceutical and taxonomic) on these species, might be highly rewarding.

CALCIPHILES AS INDICATOR SPECIES. Brown (1938) stated that many species found on Indian mounds and middens that he examined in south Louisiana may be common on alluvial soil elsewhere in that state. He thought that the mound vegetation may have represented a relict. The investigated Hancock marsh mound vegetation, however, can not be relict, since most of the plant species, especially those considered indicators, are calciphiles. Their presence is apparently favored and determined by the large amount of calcium contained in the clam shells. These calciphiles, paradoxically, have not been found on recent deposits of oyster shells, left by European man during the past three centuries.

Indicator species (Table 2) are those species that represent consistent and reliable indicators of the shell deposits on the studied middens. This does not preclude their occurrence elsewhere in other habitats. Several of the indicator species are more frequently found on Indian occupation sites than others. They are also found on occupational burial sites (mounds) on the adjacent terrestrial mainland and may also serve as indicator species for both marsh and terrestrial occupation sites (Eleuterius, unpublished data). These are *Juniperus silicola, Aesculus pavia, Erythrina herbacea*, and *Morus rubra.*

The presence of shell midden within the salt marsh ecosystem provides unique habitats for an unusual flora which increases the diversity of our estuaries. The effects of these specialized, isolated plant communities on the surrounding marsh is of considerable interest for further studies.

ACKNOWLEDGEMENTS

We thank Dr. Sidney McDaniel for identifying many of the plant species and his helpful comments. Dolores Smith and Darlene Jennings provided technical assistance.

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NOTES

NOTES ON THREE SPECIES OF *OPHIOGLOSSUM* FROM NORTH CAROLINA—While making a study of over 4200 sheets of *Ophioglossum* from 114 different herbaria, the senior author became aware that the only *Ophioglossum* common to North Carolina was *O. vulgatum* L. var. *pycnostichum* Fern. Specimens of this fern were examined from 32 counties. The only other species from the state was *O. crotalophoroides* Walter, and it was known only from a collection made on Dec. 9, 1956 on the lawn of Duke University Marine Station in Carteret County. Since other species of *Ophioglossum* are much more common than the number of sheets in herbaria indicate, it seemed probable that others could also occur in the Coastal Plains Province of North Carolina. A field trip was made in March, 1976 to look for these ferns in North Carolina.

On March 4, 1976, Thomas collected specimens of *O. nudicaule* var. *tenerum* from Brunswick County. The locality is: Bennett's Cemetery just west of Singletree Creek, 1.5 miles west of U.S. 17 near Hickman Crossroads (*Thomas 48453*). It is common at this site with *O. crotalophoroides* in sandy soil. No other collections of this fern from North Carolina were made.

Later, the same afternoon, Thomas collected *O. petiolatum* new to North Carolina. The locality is: Lawn of Letties Grove Pentecostal Free-Will Baptist Church, south of U.S. 17 east of Shalotte, Brunswick County (*Thomas 48454*). Thomas and Marx spent March 6-7, 1978 searching for *Ophioglossum* in eastern North Carolina. We found *O. petiolatum* from Craven (*Thomas* and *Marx 48476*), Carteret (*48489*), Beauford (*48502*), Washington (*48509*), and Dare (*48524*) counties.

Although *Ophioglossum crotalophoroides* had been known only from one county, the authors found it to be abundant in sandy, grassy areas such as cemeteries and school lawns. We made collections from Brunswick (*48452*), Craven (*48475*), Carteret (*48482*), Beaufort (*48506*), Pamlico (*48503*), Martin (*48506*), Washington (*48512*), Hyde (*48516*), and Dare (*48525*) counties.

We searched for *O. crotalophoroides* in southeasternmost Virginia with no success. We were hampered by a cold, rainy, and windy day that made crawling on the ground very miserable and seeing small plants almost a possibility. No doubt *O. crotalophoroides* and *O. petiolatum* will eventually be found in the Coastal Plain area of Virginia. *R. Dale Thomas, Biology Department, Northeast Louisiana University, Monroe, LA 71209 and Paul S. Marx, Botany Department, University of North Carolina, Chapel Hill, NC, 27514.*

SIDA 8(1): 113. 1979.

NEW STATE RECORDS FOR RANUNCULACEAE IN THE SOUTHEASTERN UNITED STATES—During continued studies of the Ranunculaceae for the forthcoming *Vascular Flora of the Southeastern United States,* the following localities constitute, so far as I know, new state records for the species indicated below.

1. RANUNCULUS FASCICULARIS Muhlenberg ex Bigelow. GEORGIA: Dade Co., moist shady deciduous forest, SW of Trenton, 12 Apr 1964, *Williams s.n.* (UNA!).
2. RANUNCULUS TRILOBUS Desfontaines. TEXAS: Harrison Co., in a field off Interstate 20 at Waskom, 15 Apr 1974, *MacRoberts 982* (LSUS!).
3. THALICTRUM DASYCARPUM Fischer & Avé-Lallemant. ALABAMA: Greene Co., common in rich low woods 1 mi E of Boligee, 9 May 1969, *Thomas 2059* (UNA!).
4. THALICTRUM DEBILE Buckley. MISSISSIPPI: Lowndes Co., common in oak-hickory-cedar ridge in the Black Belt region, 9 mi E of State College, 25 Mar 1968, *McDaniel 10397* (GA!).

I am indebted to the curators of the various herbaria for their loan of the specimens during this study.—*Carl S. Keener, 202 Buckhout Laboratory, The Pennsylvania State University, University Park, PA, 16802.*

CUPHEA CARTHAGENENSIS (JACQUIN) MacBRIDE—THE CORRECT ORTHOGRAPHY.—With the publication of Radford, Ahles, & Bell's *Manual of the Vascular Flora of the Carolinas* (1964) a typographical error was introduced in the treatment of *Cuphea carthagenensis* ('*C. carthagensis*') which was repeated in Correll & Johnston's *Manual of the Vascular Plants of Texas* (1970) and Correll & Correll's *Aquatic and Wetland Plants of Southeastern United States* (1972). The error now appears more and more frequently on herbarium labels and in print (e.g. SIDA 7: 137).

In hopes of preventing perpetuation of a misspelling I began this note only to face the question of what the correct spelling should be. The original spelling suggested the epithet should be *carthagenensis*, from the original *Lythrum carthagenense* Jacquin (Enumeratio Pl. Carib. 22. 1760) based on plants collected at Cartagena, Columbia, S. A. As a latinized place name, however, the epithet would be correctly formed by the stem *carthagin-* and the adjectival suffix *-ensis* denoting place of origin (Stearn, W., *Botanical* Latin, p. 218. 1966). To clarify the matter I consulted Dr. Dan Nicolson, expert in botanical orthography at the Smithsonian Institution. His clarification is one which many may find useful, particularly since today so few taxonomists are well-versed in the Latin necessary for correct formulation of new epithets.

"The problem is whether a latinization of the Spanish Cartagena should or can yield a stem *cartagen-* (directly Spanish), *carthagin-* (directly from classical Latin

Carthago, genitive *carthaginis*) or an intermediate *carthagen-*. Jacquin's stem, *carthagen-*, represents a latinization of Cartagena as *Carthagena*, treating it as if it were a First Declension name (genitive *carthagenae*, stem *carthagen-*). This is clearly not classical Latin which would be *Carthago* (genitive *carthaginis*, stem *carthagin-*) of Third Declension. Purists would object to such a neolatinization as *Carthagena* but it strikes me as a perfectly reasonable option. As such I believe *carthagenensis* should be maintained under the paragraph of Art. 73 (ICBN) which states that when changes made in orthography by earlier authors who adopt geographic names are intentional latinizations, they are to be preserved.

"In another case, *Panicum chartaginense* Swartz (*Nov. Gen. Sp.* p. 22. 1788), Swartz has made yet another neolatinization of Cartagena which he cites as *Chartagena*. A classical scholar would substitute *carthaginense*, but under the Code I believe this would not be acceptable and that the original spelling should stand.

"Obviously it is hard to draw a firm distinction between orthographic (including typographic) errors and intentional latinizations. One can say that *carthagenense* and *chartaginense* are errors to justify correcting both to *carthaginense*. Likewise, one can say that these are intentional latinizations and accept original spelling. Intention is subjective and can lead to legitimate disagreement in cases like this. However, the Preamble to the Code tells us that, 'Other considerations, such as absolute grammatical correctness, regularity or euphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory.' Under this concept I favor accepting original spelling, in most cases" (Pers. comm., 1978).

The correct epithet is thus *Cuphea carthagenensis*, not *C. carthaginensis* or *C. carthagensis*. Users of the floras cited above should correct the name in those works to include the omitted syllable.—*Shirley A. Graham, c/o Alan Graham, Dept. of Biological Sciences, Kent State University, Kent, OH, 44242.*

ZAMIA (CYCADACEAE) NEW FOR GEORGIA—This is the first report for the natural occurrence of *Zamia* in Georgia. It is reported by Small (1933) for Florida, occurring the most abundantly in the peninsular portion of the state. Lawrence (1951) states that *Zamia* in the United States is "restricted almost exclusively to Florida, with an additional station reported in adjoining Alabama." There appear to be no specimens to support the natural occurrence of *Zamia* in Alabama. Dr. Robert Kral of Vanderbilt University, who has been working intensively on the flora of Alabama for several years, says in a recent communication that to his knowledge it does not and has not occurred naturally in Alabama, but that "there is every likelihood that someone could have reported it as an escape—."

In northeast Florida *Zamia* is documented by herbarium specimens north into St. John's County. The Georgia records are from Camden and Glynn Counties, with Duval and Nassau Counties, Fla., intervening. The classification and nomenclature of *Zamia* species in Florida are in confusion. Until these problems are resolved it seems best to refer to the Georgia material as

Z. umbrosa Small which Small (1933) reports for "Hammocks, sand-dunes, and shell mounds, NE Fla."

The first collection presumed to be from Georgia was sent in for naming to the University of Georgia Harbarium in 1928 by Gertrude Proctor. Within a year or so after my arrival at the University of Georgia in 1938 I corresponded with Ms. Proctor in regard to the *Zamia*. The specimen had been given to her for naming from near Woodbine, Camden County. Ms. Proctor could not remember or find out who sent the specimen, but thought it was collected in a hammock. She and I searched considerably for the species in Camden County without success. There seemed to be a strong possibility that the specimen had been collected in Florida by someone living near Woodbine. Hence, I did not report *Zamia* for Georgia at that time.

My beliefs are now altered by my collection of *Zamia* from St. Simon's Island, Glynn County, where, according to Albert Fendig, Sr., a local resident, it occurs in a few scattered natural localities, but nowhere abundantly. My collection was made from one of three plants under a *Quercus virginiana* tree in a woods dominated by this and other evergreen species. *Pinus* was scattered, *Vitis* common.

In view of the above, *Zamia* should be considered native to Camden and Glynn Co., Georgia. The collections reported are: Camden Co.: [with male cone] Apr 1928, GA18054. Glynn Co.: *Duncan 26359*. Vigorous plant with about 20 leaves and "fruiting."—Elev. ca. 25 ft. 17 Sep 1971, GA100484. —*Wilbur H. Duncan, Department of Botany, University of Georgia, Athens, GA, 30602.*

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GALIUM SPECIES NEW TO THE SOUTHEASTERN UNITED STATES—While preparing a treatment of *Galium* for the *Flora of the Southeastern United States*, I examined specimens which proved to be *Galium tricornutum* Dandy and *Galium palustre* L. Both species are previously unrecorded for the southeastern United States.

Galium tricornutum is a Eurasian species which occurs sporadically in the eastern United States and is reported from California (Munz, 1959) and western Oregon (Hitchcock, 1959). This species superficially resembles *G. aparine* L.

Specific collection data for specimens from the southeastern United States are as follows: ARKANSAS: Miller Co.: Red River bottom, E of Texarkana, 3 May 1951, *Moore 510145* (UARK). GEORGIA: Oglethorpe Co.: banks of artificial pond, just W of Dry Fork Creek between Lexington and Washington, 17 May 1952, *Duncan 13541* (GA). SOUTH CAROLINA: Cherokee Co.:

roadside ditch, 2.4 mi N of jct. SC Rt. #150 and US Rt. #29 on SC Rt. #150 (N of Gaffney), 13 Apr 1957, *Ahles 22713* (NCU). Greenwood Co.: field, SC #34, 2.5 mi SW of Ninety-Six, 30 Mar 1957, *Radford 20103* (NCU).

Galium palustre L. is also a Eurasian species which previously has been introduced in the United States in New England, New York, Pennsylvania, Michigan, and Wisconsin (Fernald, 1950) and which closely resembles *G. tinctorium* L.

Specific collection data for the one known specimen from the southeastern United States is as follows: WEST VIRGINIA: McDowell Co.: wet ditch, Anawalt, 17 Jun 1969, *Music s.n.* (WVA). Presently it is unknown whether this species is established in the area of collection or merely a waif.—*Cheryl A. Lawson, 960 Oakridge, Duncan, Oklahoma, 73533.*

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NOTES ON *MITRACARPUS HIRTUS (M. VILLOSUS)* AND *SCIRPUS CALIFORNICUS* IN MISSISSIPPI—*Mitracarpus hirtus* (L.) DC. (Nicholson, 1977) has been previously reported in the continental United States from southern Texas (Correll & Johnston, 1970, as *Mitracarpum hirtum* (L.) DC.), central Florida (Ward, 1976, as *Mitracarpus villosus* (SW.) DC.), and most recently from southern Louisiana (Wunderlin, 1979, as *Mitracarpus hirtus*). In the course of identifying a Rubiaceous collection from R. Dale Thomas, Northeast Louisiana University, I discovered an SMU collection of *Mitracarpus hirtus* misidentified as *Spermacoce glabra* from southern Mississippi. This is apparently the only known record of it from that state. Collection data: Mississippi. Pearl River Co.: cultivated field with *Crotalaria spectabilis*, 2 mi N of Henleyfield, 15 Nov 1964, *Sargent 8542* (SMU). This is about 12.5 mi NW of Picayune on hwy 43, which is around 15 mi NE of the Louisiana collection reported by Wunderlin. Wunderlin's report from Louisiana is based on a later collection from St. Tammany Parish: waste place RR, Abita Springs, 3 Oct 1970, *Thieret 32568* (FSU).

I suspect the two collections to have their origin from one introduction possibly originating in Mississippi based on collection dates and localities.

Scirpus californicus (C.A. Mey.) Steud. is presently known in the United States from Arkansas and Texas west to California. It is believed that this is the first known collection to be reported from Mississippi.

Mississippi. Hancock Co.: low wet areas, Bay Saint Louis, 10 Aug 1952, *Demaree 32719* (SMU). This extends the known range of *S. californicus* about 275 mi eastward.—*Barney Lipscomb, Herbarium, Southern Methodist University, Dallas, TX, 75275.*

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DOCUMENTED PLANT CHROMOSOME NUMBERS 1979:1[a]

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Figs. 1–12 are tracings from photomicrographs. All figures represent mitosis in root tips. Figs. 1, 3, 5, and 7–12 show chromosomes at metaphase; Figs. 2, 4, and 6 show chromosomes at anaphase (2 sets per figure).

ALISMATACEAE

ALISMA TRIVIALE Pursh.[b] (Fig. 1.) 2n=28. CANADA, Reg. Mun. Hamilton-Wentworth: *Pringle 1286* (HAM).

SAGITTARIA CUNEATA Sheldon.[b] (Fig. 2.) 2n=22. U.S.A., Mich., Presque Isle Co.: *Pringle 1225, 1273* (illus.) (HAM).

SAGITTARIA LATIFOLIA Willd.[b] (Figs. 3,4.) 2n=22. CANADA, Ont., Reg. Mun. Hamilton-Wentworth: *Pringle 1285* (HAM).

ARACEAE

ARISAEMA MACROSPATHUM Benth.[d] (Figs. 5,6.) 2n=28. MEXICO, México, Mun. Temascaltepec: *Duncan et al. 2486* (MICH).

LILIACEAE

CLINTONIA BOREALIS (Ait.) Raf.[b,c] (Fig. 7.) 2n=28. U.S.A., Mich., Cheboygan Co.: *Pringle 1224* (HAM).

CLINTONIA BOREALIS (Ait.) Raf.[b,c] (Fig. 8.) 2n=32. U.S.A., N.H., Coös Co.: *Pringle 1277* (HAM). (Documentation for report in Utech, F., & L.B. Thien, Michigan Bot. 12:122—123. 1973.)

RANUNCULACEAE

CLEMATIS INTEGRIFOLIA L.[b] (Fig. 9.) 2n=16. Cult.: *Pringle 345* (HAM).

COMPOSITAE

SOLIDAGO CANADENSIS L. var. HARGERI Fern.[b] (Fig. 10.) 2n=18. CANADA, Ont., Reg. Mun. Hamilton-Wentworth: *Pringle 1372* (HAM).

SOLIDAGO OHIOENSIS Riddell.[b] (Fig. 11.) 2n=18. Cult. ex U.S.A., Mich., Cheboygan Co.: *Pringle 1289* (HAM).

SOLIDAGO RIDDELLII Frank.[b] (Fig. 12.) 2n=18. Cult. ex CANADA, Ont., Essex Co.: *Pringle 1250* (HAM).

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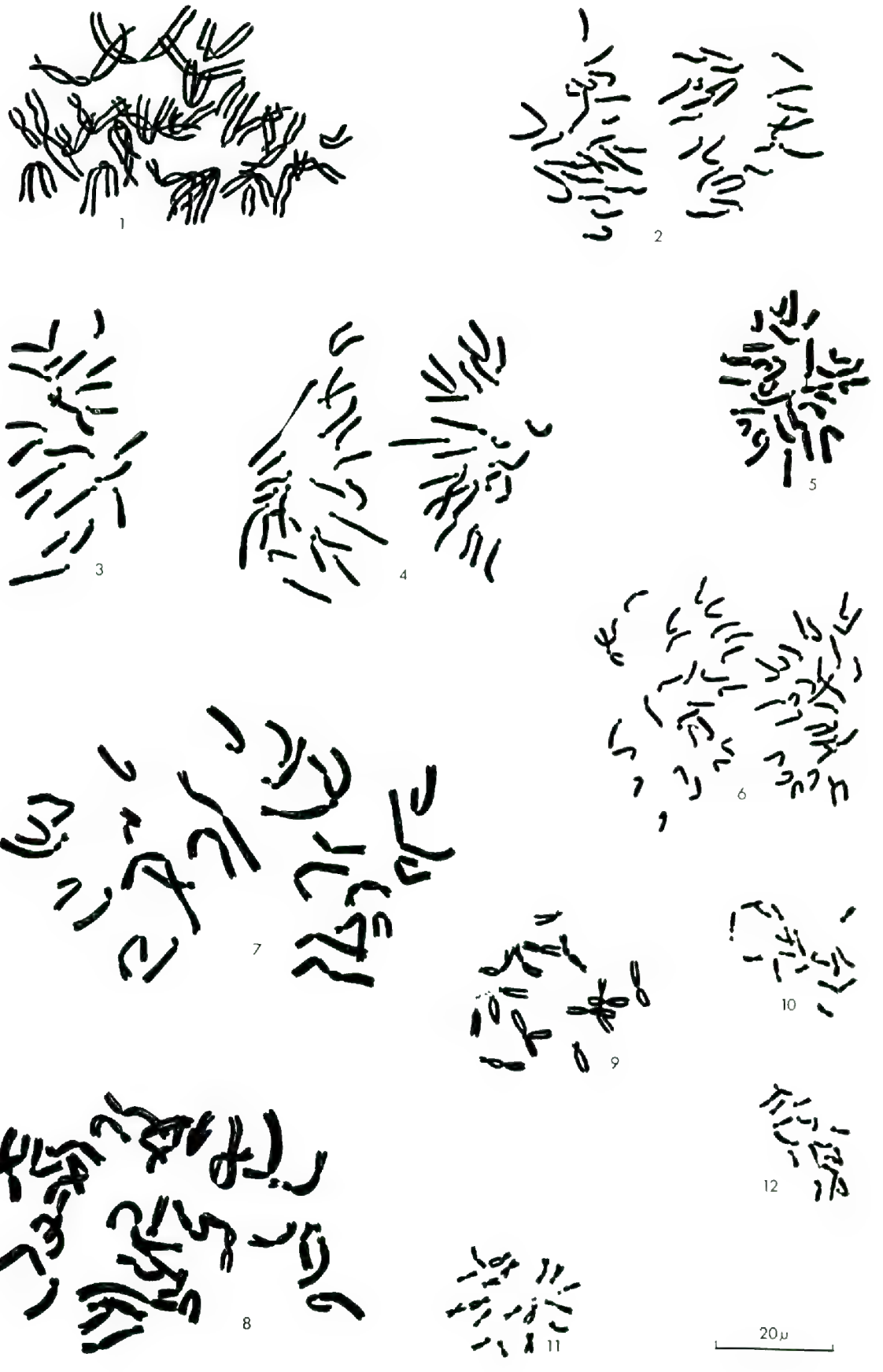
[a] Contribution No. 32 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

[b] Taxon for which the same chromosome count has been published previously.

[c] Taxon for which a different chromosome count has been published previously.

[d] Taxon for which no chromosome count has been published previously.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NOTICE

VASCULAR PLANTS OF NORTH AMERICA NORTH OF MEXICO

The Flora North America project (FNA) was recently revitalized by the Man and Biosphere Program (MAB) as a binational effort between the United States and Canada to produce a conventional flora of the vascular plants of North America north of Mexico using traditional methods. Initial funding for the proposed five-volume work is being provided by the National Park Service of the Department of the Interior. The MAB/FNA Program Council plans to coordinate the research which will be necessary to produce a floristic publication of high scientific quality pertinent to national needs.

The Program Council has appointed an Editorial Subcommittee consisting of Dr. Reed C. Rollins, Chairman, Gray Herbarium of Harvard University; Dr. Howard S. Irwin of the New York Botanical Garden; and Dr. Roy L. Taylor of the University of British Columbia Botanical Garden. Dr. James L. Reveal of the University of Maryland has been appointed Editor. Their function will be to stimulate and coordinate the efforts of the botanical community in the writing of the flora. Toward this goal, the Editorial Subcommittee is currently working on a proposed format for the flora. Initial efforts will be toward the production of a volume treating the monocotyledonous plants, with a volume on the sympetalous dicotyledonous plants to follow next. The remaining three volumes will be worked on in the future.

Long-term funding for the flora project is being explored by the Program Council, chaired by Dr. Peter H. Raven of the Missouri Botanical Garden. It is hoped that the flora project will be completed by 1990.

Individuals wishing additional information or interested in contributing to the project, and in particular treatments of the monocots and sympetalous dicots should write to:

Dr. James L. Reveal, Editor
MAB/FNA Project
Department of Botany
University of Maryland
College Park, Maryland 20742

SIDA 8(1): 121. 1979.

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SIDUS SIDARUM—III. *SIDA RZEDOWSKII* SP. NOV., INCLUDING A PRELIMINARY DISCUSSION OF THE *SIDA ELLIOTTII* SPECIES GROUP

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Eight North American species of *Sida* show strong affinities with one another and merit recognition as a distinct species group, as was first noted by Small (1898). The characters that unite them include (1) distinctive conformation of the fruits (generally oblate) and of the mericarps (see Figure 1), which are usually about 8 in number; (2) leaf shape that varies from broadly elliptic to narrowly linear (never rhombic or cordate-ovate); (3) a tendency in some species to rose-colored flowers (at least on drying), reaching an extreme in *S. rzedowskii* with purplish flowers; and (4) a tendency to extreme shortening of the apical internodes in several species, giving rise to congested apical inflorescences.

The abbreviated apical internodes are well expressed in the newly described species, *Sida rzedowskii*, and are suggestive of a similar condition in *Sida* sect. *Malachroideae* (Clement, 1957; Fryxell, 1975). In the latter group of species, typified by *S. anomala* St.-Hilaire, the condition is described by Schumann (1891) as "Flores petiolis bractearum foliacearum adnati, saepissime apice ramulorum subumbellato-congesti" and by Kearney (1954) as "Peduncles adnate to the petiole of the subtending leaf or bract." Careful examination indicates that the adnation of parts characteristic of sect. *Malachroideae* is simply an extension and intensification of the shortening of the apical internodes found in *S. rzedowskii*, *S. neomexicana*, and *S. inflexa* and occasionally expressed weakly in *S. elliottii*. Thus, we find in the present group of species an intermediate condition between the extreme characteristic of sect. *Malachroideae* and the less specialized condition found in the remainder of the genus. It is plausible to suggest that this tie indicates a phylogenetic link connecting sect. *Malachroideae* with the balance of the genus. It should be noted that sect. *Malachroideae* also has a tendency to rose-colored corollas and elliptic leaves, similar to the tendency in the *S. elliottii* group.

I am explicitly not suggesting, however, that the members of the *S. elliottii* group should be included in sect. *Malachroideae*. They are distinguished from the latter by their erect (not procumbent) habit and by their more numerous mericarps that lack rugulose or muriculate ornamentation on the

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dorsal walls, as well as by other characters. The *S. elliottii* group is not now given formal taxonomic status, pending further studies leading to a better understanding of infrageneric groupings in *Sida*. It is simply recognized for the present as a coherent group, without rank, and the following key is presented as an aid to distinguishing the species.

Species are sometimes difficult to distinguish within this group. For example, some intergrading of characters occurs between *S. elliottii* and *S. lindheimeri* (e.g. in Arkansas). In this instance it may be preferable, following more detailed study, to merge the species and distinguish the taxa as *S. elliottii* var. *elliottii* and *S. elliottii* var. *texana* Torrey & Gray. Similarly in northern Mexico, it is sometimes difficult to distinguish *S. elliottii* and *S. nomexicana*. These taxa are retained in specific rank in the key, following prevalent usage. A detailed analysis of these problems is merited.

KEY TO THE SPECIES OF THE SIDA ELLIOTTII GROUP

1. Pedicels up to 15 cm long, usually more than twice the length of the subtending leaves
   2. Leaves narrowly lanceolate, 7–10(–15) times as long as wide; calyx 6–7 mm long . . . *S. longipes*
   2. Leaves broadly elliptic, 1.2–2 times as long as wide; calyx 9–11 mm long . . . *S. potosina*
1. Pedicels no more than 6 cm long, usually shorter than the subtending leaves
   3. Apical congestion of flowers and fruits conspicuous, as a result of abrupt shortening the apical internodes
      4. Corolla rose or purple (with yellow center); leaves elliptic, 2–6 times as long as broad . . . *S. rzedowskii*
      4. Corolla yellowish, sometimes fading rose; leaves lanceolate to linear, usually 5–10 (–20) times as long as broad
         5. Plants freely branched from the base; leaves narrowly lanceolate to linear, 3–6 mm broad . . . *S. neomexicana*
         5. Plants sparingly branched; leaves broadly elliptic, 10–15 mm broad . . . *S. inflexa*
   3. Apical congestion of flowers and fruits slight
      6. Calyx 7–10 mm long; pedicel often 2–5 cm long, shorter than to slightly exceeding subtending leaf . . . *S. lindheimeri*
      6. Calyx 5–7 mm long; pedicel usually 1–3 cm long, shorter than subtending leaf
         7. Leaves linear, often 15–20 times as long as wide; mericarps 8–11 . . . *S. elliottii*
         7. Leaves elliptic, usually 1.5–3 times as long as wide; mericarps 5–8 . . . *S. turneroides*

SIDA ELLIOTTII Torrey & Gray, Flor. N. Amer. 1:231. 1838 (based on *S. gracilis* Elliott, 1822, non Richard, 1792). (*S. rubromarginata* Nash, 1896; *S. leptophylla* Small, 1898). North Carolina south to Florida and west to southernmost Missouri and Arkansas; eastern Mexico from Veracruz and Querétaro north to Nuevo León and the Coastal Bend of Texas.

Sida rubromarginata and *S. leptophylla* have been maintained by Kearney (1954) and others as distinct from *S. elliottii*, but they seem to be relatively broad-leaved and relatively glabrous variants (respectively) of it.

Although Elliott originally described *S. elliottii* as glabrous, examination of Elliott's type reveals that this is incorrect (Weatherby, 1942).

SIDA LINDHEIMERI Engelmann & Gray, Boston J. Nat. Hist. 5:213. 1845. (*Sida texana* (Torrey & Gray) Small, 1903). Central Texas and Louisiana to Sinaloa (1 specimen); cited from Guatemala by Standley & Steyermark (1949) and from Chiapas by Standley (1923), but these may refer to *S. elliottii.*

SIDA LONGIPES A. Gray, Pl. Wright. 1:19. 1852. Trans-Pecos Texas and Coahuila.

SIDA NEOMEXICANA A. Gray, Proc. Amer. Acad. Arts 22:296. 1887. Trans-Pecos Texas, New Mexico, Coahuila, Chihuahua, and Durango.

SIDA POTOSINA Brandegee, Univ. California Publ. Bot. 4:184. 1911. San Luis Potosí and Tamaulipas.

SIDA INFLEXA Fernald, Rhodora 42:463. 1940. A restricted endemic in southeastern Virginia.

SIDA TURNEROIDES Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 22:90. 1940. Hidalgo to Tamaulipas.

SIDA **rzedowskii** Fryxell, sp. nov.

Planta herbacea perennis, minute stellato-pubescens, internodiis apicalibus abrupte abbreviatis. Laminae foliorum ellipticae, dentatae, utrinque stellato-pubescentes. Pedicelli in axillis foliorum summorum, solitarii, plerumque in apicem congesti. Calyces saepe in nervis hirsuti. Petala glabra, purpurascentes. Fructus oblati, in apicem minute pubescentes; mericarpia 8–11, laevigata vel leviter reticulata, 1-seminalia, in apicem acuta vel rotundata.

Herbaceous perennial 1–4 dm tall, the stems branched and suberect, invested with minute stellate pubescence, the internodes abruptly shortened at the apices of the branches. Leaf lamina elliptic or oblong, 1–3 cm long, (2–)3–6 times as long as wide, subacute or obtuse, dentate, 3(–5)-nerved from the base, the lateral nerves inconspicuous, with dense or sparse stellate pubescence above and beneath. Petiole densely pubescent, 4–10 mm long. Stipules 4–7 mm long, linear-lanceolate, sometimes equaling the petiole. Pedicels 1–10 mm long, solitary in the axils of the upper leaves, mostly aggregated apically (forming inflorescences similar to those of *Sida ciliaris* L., with flowers, reduced leaves, and stipules crowded together because of the shortened internodes). Calyx 4–6 mm long, with pubescence like that of the leaves except sometimes hirsute on the nerves, 10-nerved, 5-lobed, the lobes ovate-acuminate. Petals glabrous (including the claw), 6–8 mm long, markedly asymmetrical, rose to red-purple but yellowish at the base. Staminal column pallid, 2–3 mm high, slightly pubescent or glabrous; filaments 1–1.5 mm long, arising from the apex of the column; anthers yellow, few (ca. 20); pollen yellow. Styles 8–11; stigmas capitate. Fruits oblate, 5–6 mm diameter, 3–4 mm high, apically with minute stellate pubescence; mericarps 8–11, 3–4 mm high, smooth or slightly reticulate on the lateral wall, apically acute or rounded and dehiscent, 1-seeded (Fig. 1,D). Seeds 2 mm long,

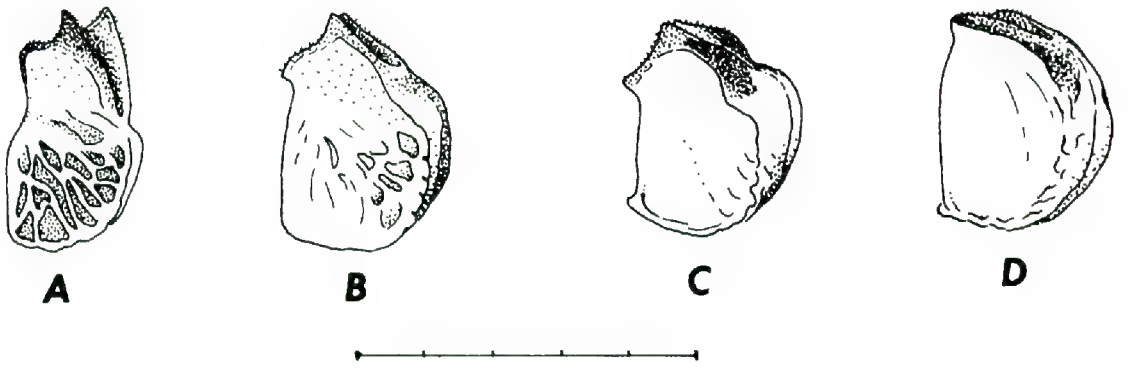

Figure 1. Comparison of mericarps of the four species of *Sida*. A, *Sida lindheimeri* (*Byrd 42*); B, *Sida neomexicana* (*Board s.n.*); C, *Sida elliottii* (*Hill 2841*); D. *Sida rzedowskii* (*Hilerio 72*). Scale = 5 mm.

glabrous, blackish.

TYPE: MEXICO: Hidalgo: Cerro Ventoso, entre Pachuaca y Real del Monte; orilla del camino, matorral de *Hechtia podantha*; alt. 2500 m; flores de color morado oscuro; 29. viii. 1965, *Rzedowski 20560* (holotype: ENCB).

Additional specimens examined:

Hidalgo: Mpio. Pachuca, 4 km al NE de Pachuca, sobre la carretera a Real del Monte, alt. 2650 m, *Rzedowski 33558* (ENCB). Mpio Tepeapulco, Cerro Tres Peñas, alt. 2500 m, *Ventura 245* (ENCB, pf).

Edo. México: Mpio. Tepotzotlán, alrededores de la Presa de la Concepción, alt. 2350 m, *Hilerio 72* (ENCB, pf); ca. 2 km al NW de Tepotzotlán, alt. 2350 m, *Huerta 41* (ENCB); alrededores de la Hacienda Lanzarote, alt. 2350 m, *Rzedowski 35021* (ENCB, pf). Mpio. Huehuetoca, vertiente W de Cerro Sincoque, alt. 2500 m, *Rzedowski 34307* (ENCB); 4 km al N de Huehuetoca, Cerro Ahumada cerca del Rancho Nuevo, alt. 2350 m, *Rzedowski 28403* (ENCB). Mpio. Atizapán, 3 km al NW de Atizapán de Zaragoza, alt. 3400 m [2400 m?], *Cruz 633* (ENCB); Cerro del Tigre, al NW de Atizapán, alt. 2500 m, *Rzedowski 32004* (ENCB, pf).

Distrito Federal: Pedregal de San Angel, cerca de San Angel, *Rzedowski 1019* (ENCB); al sur de Cerro Zacatepec, *Rzedowski 283* (ENCB).

Jalisco: Mpio. Lagos de Moreno, Paso de La Troje, Cerro La Campana, SW of Ojuelos, alt. 2100–2300 m, *McVaugh et al. 16832* (ENCB); 14 miles SW of Lagos de Moreno, *Waterfall 15659* (SMU-in part).

Chiapas: Cerro San Cristóbal, San Cristóbal de las Casas, alt. 7000 ft, *Breedlove 6001* (DS).

San Luis Potosí: Mpio. de Mezquitiq [Mexquitic], km 65 de la carretera San Luis Potosí-Zacatecas; alt. 2090 m; *García 665* (CHAPA, pf).

The new species is named in honor of Dr. J. Rzedowski, author of *Vegetación de México* and coauthor of *Flora Fanerogámica del Valle de México*, whose extensive Mexican collections, especially in the Valley of

Mexico, have brought this species to light. It is especially noteworthy that this species occurs rather commonly in the Valley of Mexico at elevations of 2300–2700 m, higher than any other North American species of *Sida* is known to occur. Moreover, it appears to be confined to these high elevations, extending from Chiapas to northern Jalisco and southwestern San Luis Potosí.

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TAXONOMY OF THE *VERBESINA VIRGINICA* COMPLEX (ASTERACEAE)

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The *Verbesina virginica* complex contains three taxa, *V. virginica* L. var. *virginica, V. v.* var. *laciniata* (Poir.) Gray and *V. microptera* DC., in the widespread tropical section *Ochractinia*. The complex has been a source of taxonomic confusion for some time. This confusion has arisen over the segregation of the southwestern United States taxon, *V. microptera*, from the more widespread *V. virginica* and the segregation of the southeastern populations of *V. virginica* at either the specific or the varietal levels.

Verbesina microptera DC. was described from a south Texas Berlandier collection (no. *1442*) in 1836. Gray (1883) and Stanford (1976) considered this name synonymous with *V. virginica*, while Correll and Johnston (1970) treated the two taxa as distinct species, though suggesting they are conspecific.

These two taxa are commonly distinguished by the number of wings on the stem and the extent to which these wings continue into the inflorescence. Examination of herbarium material quickly shows these characters are completely unsatisfactory; the number of wings and their extent varies with the robustness of the plant and ranges from none to six in all taxa of this complex.

Coleman (1977) has performed experimental crosses on populations of all three taxa in this group and recognized *V. virginica* and *V. microptera* as distinct species while maintaining the southeastern United States populations as a variety of the former. He also points out the differing number of ray florets that distinguish between *V. microptera* (10–13) and *V. virginica* (1–5).

My examinations of herbarium and living material supports the conclusions of Coleman (1977). Furthermore, *V. microptera* is geographically isolated from *V. virginica*, the former largely restricted to the region south of San Antonio, Texas, and extending into Coahuila and Nuevo Leon, Mexico, and the latter occurring from west of Austin, Texas, north to Kansas and east to the Carolinas (Figure 1). Correlated with this geographic break (Figure 2) is a distinct morphological boundary as noted by Coleman. *Verbesina virginica* usually has three ray florets (always less than seven) with 10–13 disc florets, while *V. microptera* usually has 11 ray florets (always more than nine) with ca. 25 disc florets. No exceptions to this meristic difference have been detected in the specimens examined.

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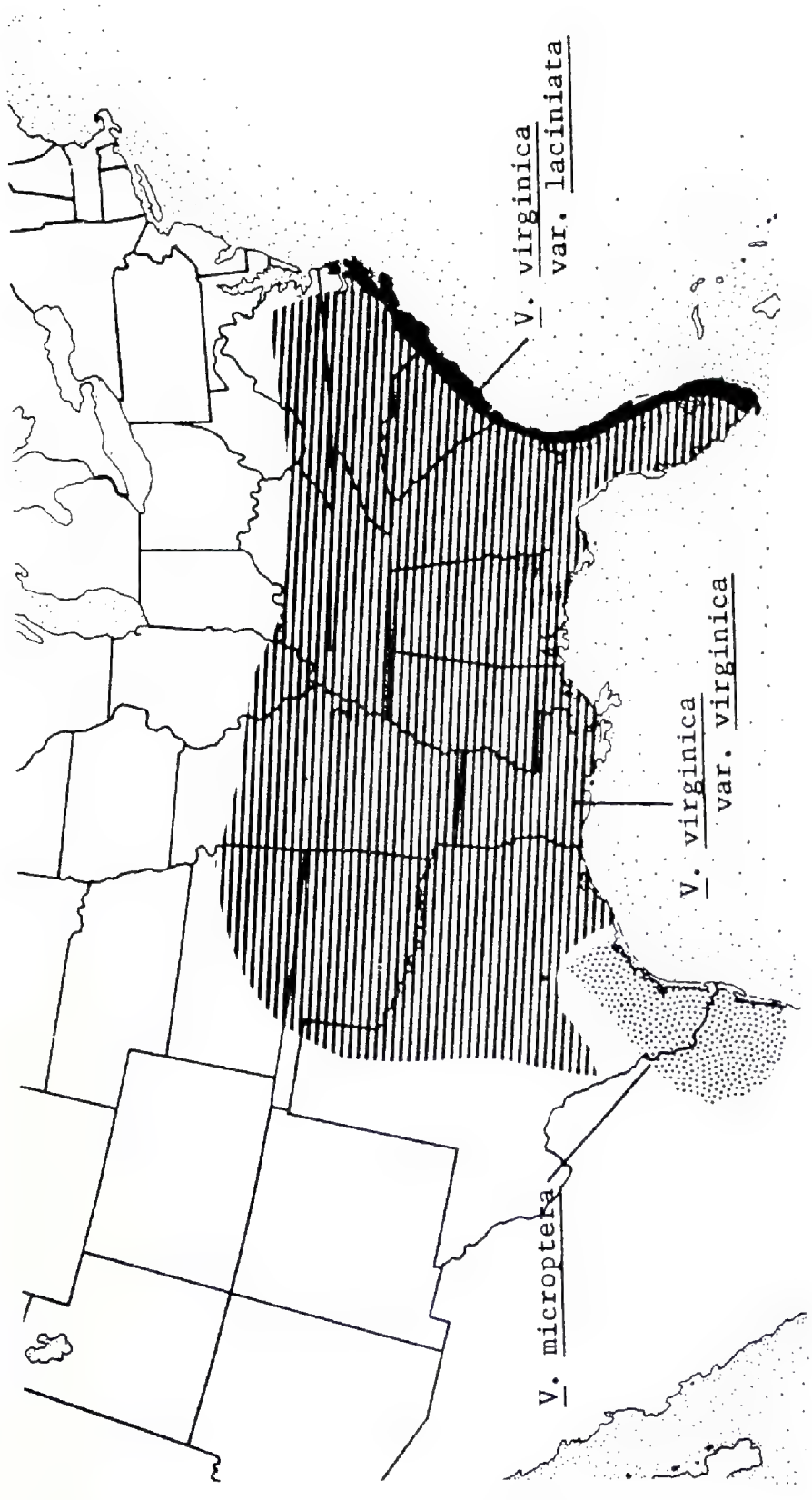

Fig. 1. Distribution of the taxa in the *Verbesina virginica* complex.

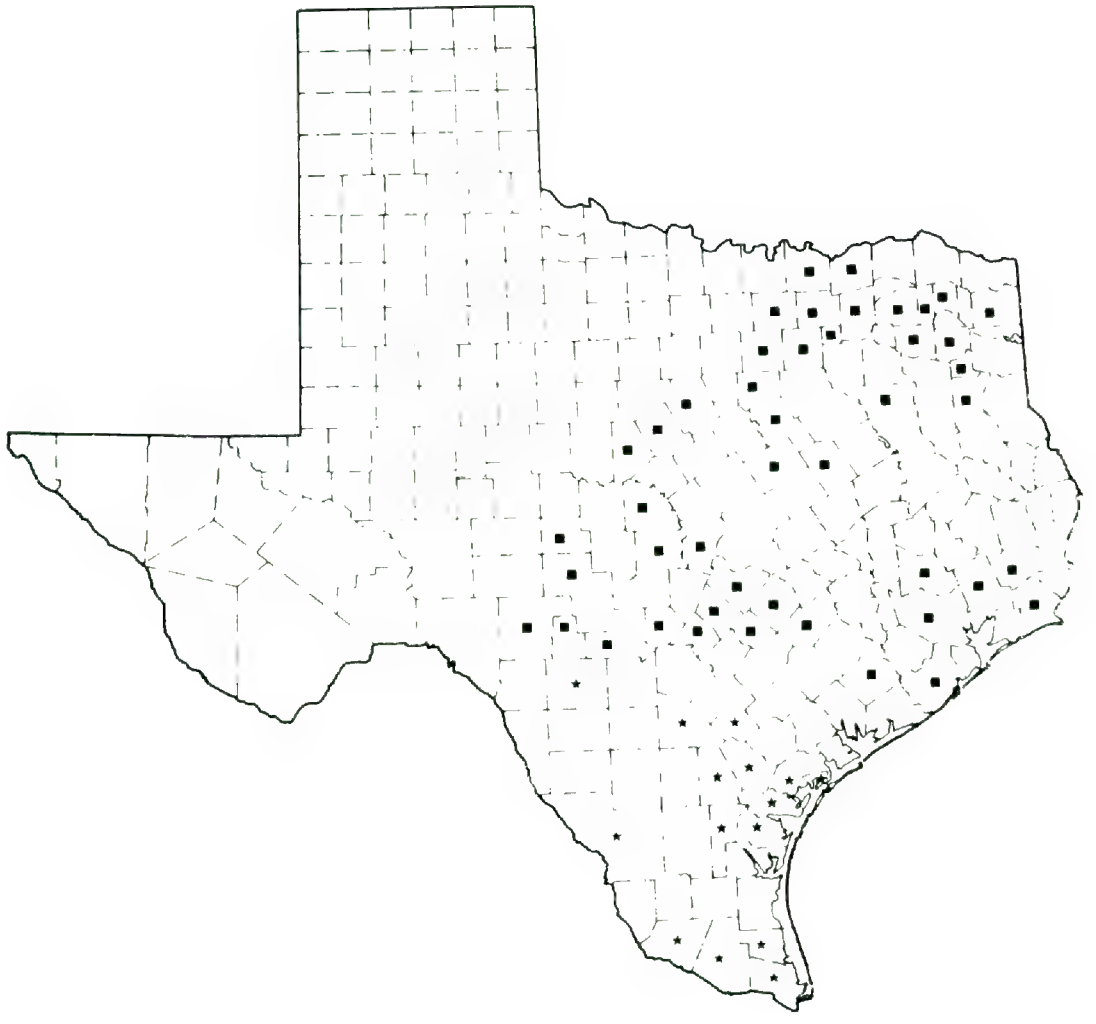

Fig. 2. Distribution of *Verbesina virginica* and *V. microptera* in Texas. *V. virginica* var. *virginica* (squares); *V. microptera* (stars).

The Atlantic coast populations of *V. virginica* differ in several characters from the typical variety. The key differences are the lobing of the lower stem leaves, the indistinct stigmatic lines in the disc floret style branches, acute pale apices and glabrous ray achenes. Long and Lakela (1971) have recognized these populations as *V. laciniata* (Poir.) Nutt., while others (Radford *et al.*, 1968) have accepted them as a variety of *V. virginica.* I am inclined to agree with the latter disposition because of the close morphological similarities between the two taxa. The most consistently reliable character distinguishing the two, leaf morphology, varies continuously from the typical. strongly dentate or serrate form to the sinuately lobed condition found in the coastal areas. Coleman (1977) also supports the latter viewpoint based on hybridization data. The pollen fertility in hybrids between

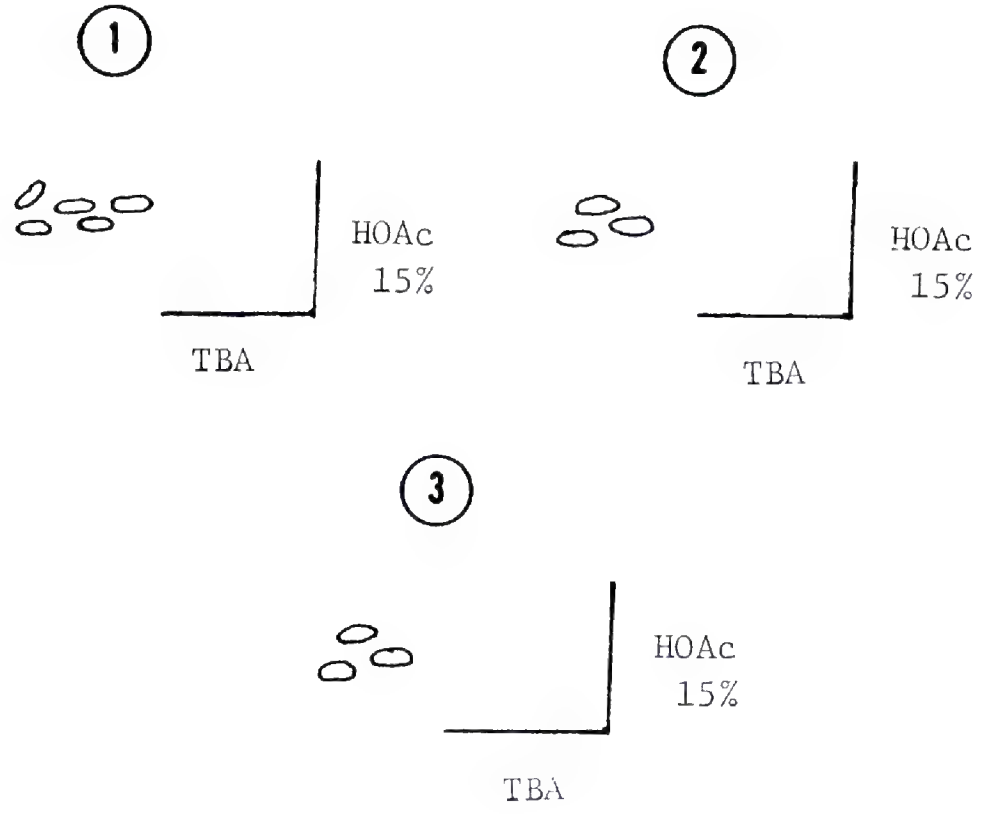

Fig. 3. 2-D chromatographic patterns of flavonoids in the *Verbesina virginica* complex. 1 *V. microptera*; 2. *V. virginica* var. *virginica*; 3. *V. virginica* var. *laciniata*.

V. v. var. *laciniata* and *V. v.* var. *virginica* is 93% (compared to eastern and western var. *virginica* crosses which yielded 95% good pollen). This may be compared to the 73% fertility in crosses between *V. microptera* and *V. virginica* var. *virginica* and 41% between *V. microptera* and *V. virginica* var. *laciniata*. Clearly, the coastal United States taxon is more compatible with the typical genome than is *V. microptera*.

Further support for this disposition of taxa can be found in their flavonoid chemistry. *V. virginica* var. *virginica* and *V. virginica* var. *laciniata* produce identical patterns (Figure 3); they each produce three glycosides of kaempferol. *V. microptera* produces those same three compounds and two additional kaempferol glycosides as well. Chromatographically, the two varieties are obviously more closely related to each other than either is to *V. microptera*.

My conclusion, based on these examinations, is to recognize two species, *V. microptera* and *V. virginica*; the latter being comprised of two varieties.

KEY

Ray florets fewer than seven; disc florets fewer than 15. . . . . *V. virginica*
Stem leaves unlobed . . . . . var. *virginica*
Stem leaves lobed or pinnately divided . . . . . var. *laciniata*
Ray florets more than 9; disc florets more than 20 . . . . . *V. microptera*

VERBESINA VIRGINICA L. Sp. Pl. 2:901. 1753. TYPE: USA, Virginia. *Clayton 166.* (Holotype:BM).

Herbaceous perennials, 0.5–3.5 m tall. Stem erect, striate, unbranched until the inflorescence, with (0–)1–6 decurrent wings up to 5 mm wide, vestiture puberulent below to tomentose above. Leaves lanceolate to broadly ovate in outline, laciniately lobed to entire, margins smooth to serrate, upper surface glabrous to scabrous, lower surface tomentose; petioles winged, wings usually decurrent and extending below the base onto the stem. Capitulescence corymbose, ultimate tomentose peduncles less than 1 cm long. Heads to 2 cm in diameter (including the rays); receptacle short-conical. Involucre 2-seriate, bracts oblanceolate, pubescent, keeled by a prominent midevein, outer series short, innter series grading into the pales, apex acute. Pales oblanceolate to weakly trifid, conduplicate, keeled by the prominent midvein, apex acute or acuminate. Ray florets 1–5 (7), pistillate and fertile, corollas white, tube pubescent, 1.6–2.1 mm long, ligule glabrous, 4.4–5.3 mm long, notched at the apex; style branches linear, exserted from the tube. Disc florets 9–13, corollas white, tube short, 0.3–0.6 mm long, pubescent; limb narrowly cylindric, glabrous, 2.3–2.9 mm long; style branches acute, stigmatic lines distinct or indistinct; anthers black, apical appendages acute. Ray achenes black, winged, minutely tuberculate to sparsely pubescent, laterally compressed, 4.1–4.9 mm long, 1.1–2.1 mm wide; wings 0.2–1.2 mm wide; pappus of 2 barbed aristae to 2.5 mm long. Disc achenes black, winged, glabrous, laterally compressed, 4.3–5.7 mm long, 0.9–2.0 mm wide; wings and pappus as in the ray achenes. Flowering Aug.-Dec. Chromosome number, $n = 17$.

VERBESINA VIRGINICA L. var. VIRGINICA—*Phaethusa virginica* (L.) Britton, Ill. Fl. ed. 2, 3:487. 1913.

Verbesina polycephala DC. Prodr. 5:616. 1836. TYPE: USA: Texas, Bexar County, "Bejar" (San Antonio). 1828. *Berlandier 1830.* (Microfiche G-DC!, Phototype US! Isotype MO! Sketch GH!).

Variously known as ice plant, white crown beard, frost plant or ice stickweed, *V. virginica* var. *virginica* is a widespread north American weed (Figure 1). It is characterized by unlobed, ovate-lanceolate to broadly ovate leaves. Leaf margins are highly variable, ranging from entire to serrate or dentate. More technical characters of distinction include the acuminate apex of the pales, the distinct stigmatic lines in the disc florets style branches and the sparse pubescence along the ridges at the apex of the ray achenes.

VERBESINA VIRGINICA L. var. LACINATA (Poiret) Gray, Proc. Amer. Acad. Arts 19:11. 1883. —*Siegesbeckia laciniata* Poiret, Enc. Meth. 7:158. 1806. Described from a specimen sent by *M. Bosc.* —*Verbesina laciniata* (Poir.)

Nutt., Gen. 2:170. 1817. —*Phaethusa laciniata* (Poir.) Small, Fl. Miami 195:200. 1913.

Verbesina sinuata Elliott, Sk. 2:411. 1823. Types probably at CHARL. Material indicated as sent to Muhlenberg at PH is not there.

Verbesina virginica L. var. *insularis* Rob. & Greenm., Proc. Amer. Acad. 34:560. 1899. TYPE: Fernando do Noronha. (an island in the Cape Verde Archipelago) 1887. *Ridley, Lea & Ramage s.n.* (Holotype GH!).

Although other authors regard this as a separate species, the present investigation, as pointed out above, cannot support this view. This variety commonly occurs on sandy soils along the coastal southeastern United States.

The variey *insularis* from the Cape Verde Islands is obviously an introduction from the southeastern United States.

VERBESINA MICROPTERA DC., Prodr. 5:616. 1836. TYPE: USA: Texas, 'between Laredo and Bejar". 1828. *Berlandier 1442* (Microfiche G-DC!, Isotypes GH! MO! NY! PH!. Phototype US!).

Verbesina texana Buckley, Proc. Phila.. Acad. 13:458. 1861. TYPE: MEXICO: Nuevo Leon, near Tantoyuca, province Huasteca, 1858. *Ervenberg 58.* (Lectotype [here designated]: PH! GH!).

Verbesina microptera DC. var. *mollissima* Rob. & Greenm., Proc. Amer. Acad. 34:560. 1899. TYPE: MEXICO: Nuevo Leon, Valley near Monterrey. 7 July 1888. *Pringle 1916.* (Holotype GH! Isotypes F! GH! NY(2)! PH!).

Herbaceous perennials to 2.5 m tall. Stems erect, striate, unbranched until the inflorescence; winged; glabrous to puberulent below to tomentose above. Leaves ovate-lanceolate to broadly ovate, margins serrulate, serrate or lobed, apex acuminate or rounded; base narrowing quickly to a winged petiole, the wings continuing down the stem; lower leaves up to 25 cm long, 15 cm wide; pubescence of the upper surface scabrous, lower surface tomentose. Capitulescence a corymb, ultimate peduncles tomentose, less than 1 cm long. Heads to 2.5 cm in diameter (including the rays); receptacle nearly flat. Involucre 2-seriate, bracts oblanceolate, pubescent; keeled by the prominent midvein, apex acute; inner series intergrading with the pales. Pales oblanceolate, conduplicate, keeled by the prominent midvein, 6.0–6.5 mm long, apex acute. Ray florets 11–15, pistillate and fertile; corollas white, tube pubescent, 1.1–1.6 mm long; limb glabrous, 2.7–3.3 mm long, apex with 1 or 2 notches; style branches linear. Disc florets ca. 25; corollas white, tube pubescent, 0.7–1.5 mm long, corolla narrow cylindric, 2.1–2.9 mm long; style branches narrow acute, stigmatic lines distinct; anthers black, apical appendages acute. Ray achenes black, glabrous, laterally compressed, 4.4–4.8 mm long, 1.5–1.8 mm wide; winged by 2 broad wings, 0.3–1.0 mm wide; pappus of 2 barbed aristae to 2 mm long. Disc achenes similar, 3.9–4.5 mm long, 1.4–1.7 mm wide; wings to 1 mm wide; pappus of 2 barbed aristae to 2.5 mm long. Flowering May-Nov. Chromosome number, $n = 17$.

As emphasized above, this taxon differs from *V. virginica* in the number

of ray and disc florets, as well as being geographically separated. Plants of this taxon are further distinguished from *V. virginica* by a more deltoid leaf shape, whereas the leaves of the latter narrow much more gradually along the petiole. *Verbesina microptera* also has much narrower wings on the achenes than either variety of *V. virginica.*

Verbesina microptera is closely related to the Mexican taxon *V. rumicifolia* Rob. & Greenm., from which it differs primarily in its leaf pubescence.

Excluded Taxa

V. virginica var. *palmeri* Gray = *V. rumicifolia* Rob. & Greenm.

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THE VASCULAR FLORA OF SAVAGE GULF, TENNESSEE[1]

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Remnants of pristine forests are manifestly important to both present and future generations of mankind. Such areas offer unique aesthetic experiences, demonstrate balanced ecosystems, support a rich fauna and flora, and most importantly, demand the acute awareness of persons interested in their preservation. According to Quarterman, Hemmerly and Turner (1972), a relic stand in Savage Gulf ". . . appears to be the only virgin tract of typical mixed mesophytic forest remaining in Tennessee. . . ."

Savage Gulf is within the proposed Savage Gulf Natural Area which includes the gorges and adjacent uplands of Savage Creek, upper Collins River, and Big Creek. The Tennessee Department of Conservation now owns a significant portion of this 10,000 acre Preserve and negotiations for additional land acquisitions are underway. Now that a means for protection seems assured, it is anticipated that critical habitats will be properly managed and preserved.

Past studies of the floristics and vegetation of the gorges of the Cumberland Plateau of Tennessee are those of Caplenor (1955, 1965), Clark (1966), Quarterman *et al.* (1972), and Sherman (1958). Except for occasional herbarium vouchers deposited at the University of Tennessee, Knoxville, and Vanderbilt University, no extensive collections of vascular plants had been made from Savage Gulf.

This report on the flora of Savage Gulf represents a concerted effort to obtain detailed floristic information about a remnant virgin forest and its immediate surroundings. Data were obtained on the species of vascular plants present, the occurrence of unusual habitats, and the status of rare plants. Although no vegetative sampling or quantitative analyses of plant communities were undertaken, collections were made throughout Savage Gulf and the adjacent uplands (Figure 1).

GENERAL PHYSIOGRAPHY

Savage Gulf lies on the Cumberland Plateau in eastern Grundy County

[1] Contributions from the Botanical Laboratory, The University of Tennessee, Knoxville, N.S. No. 503.

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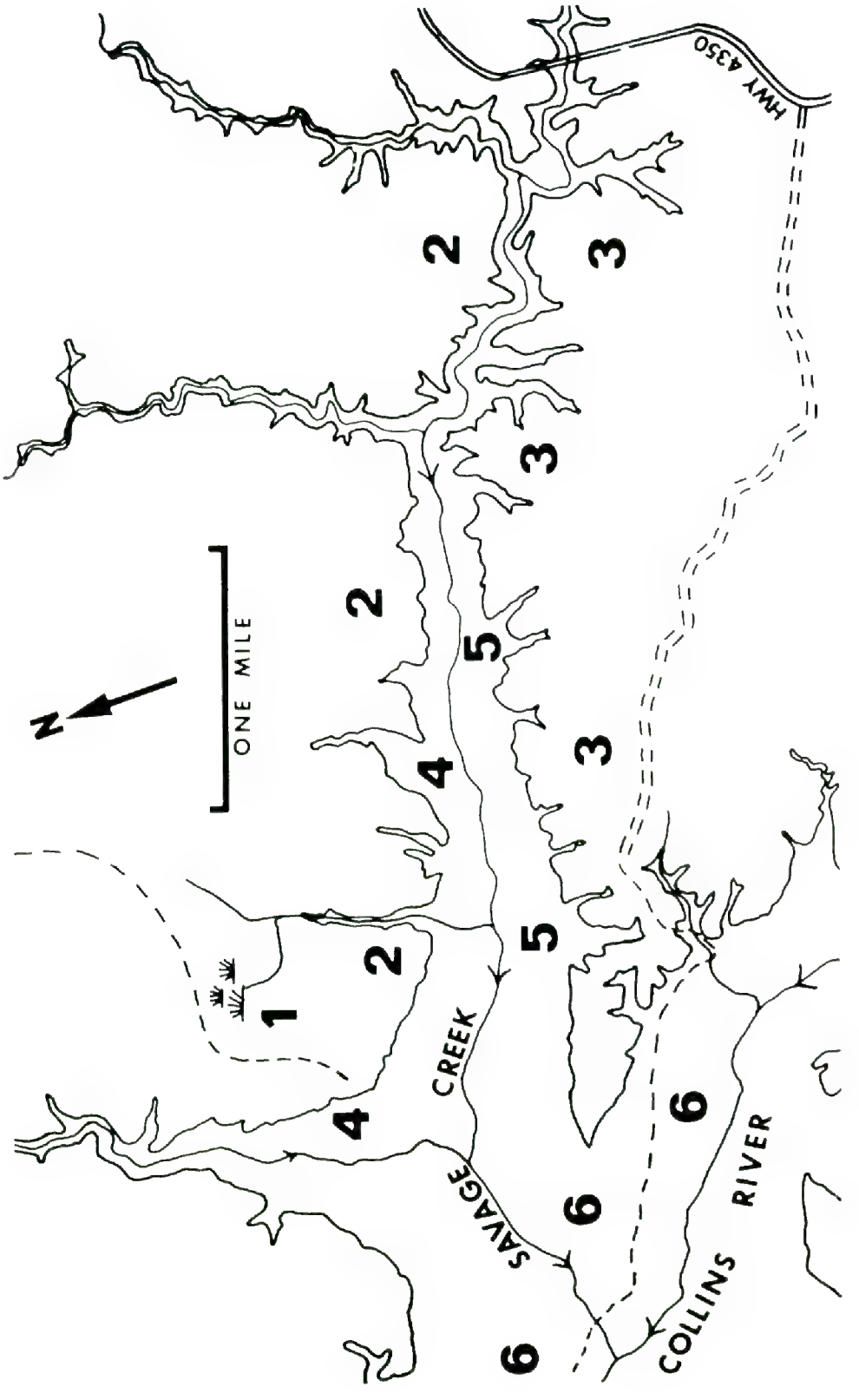

Figure 1. Savage Gulf, Grundy County, Tennessee. The gulf is outlined at the 1800 ft contour which approximates the rim. Numbers 1–6 refer to collection areas (see text for vegetation and topographic descriptions).

approximately 35 miles northwest of Chattanooga, Tennessee. The Cumberland Plateau is the southern extension of the Appalachian Plateau Province (Fenneman, 1938). Since prominent vertical escarpments are characteristics of the region, it is referred to as the "Cliff Section" by Braun (1950).

Savage Creek, the primary stream within the Gulf, flows almost due west and drops from ca. 1740 ft near its headwaters to ca. 970 ft at its confluence with the Collins River for an average gradient of 150 ft per mile. The scenic gorge is extremely steep and hazardous. The rim is roughly 1800 ft in elevation on both the north and south sides. The caprock, composed of a coarse Pennsylvanian conglomerate, is often exposed as vertical cliffs or overhangs ranging from 70 to 140 ft high. From the base of the escarpments the gorge is typically terraced and slope ranges from 45° near the base of the caprock to 15° at Savage Creek. Boulder fields of conglomerate, sandstone, and limestone bedrock fragments are common on both the north and south facing slopes.

DESCRIPTION OF THE VEGETATION

Savage Gulf is divided into six areas (Fig. 1) to facilitate annotation of the checklist and to describe the vegetation. For the most part, these areas are natural plant communities that can be defined by their unique indicator species, soils, slopes, and exposures.

Area 1 is an upland swamp that remains relatively wet during the summer and supports a rich flora throughout the growing season. Similar habitats occur infrequently throughout the Cumberland Plateau in Tennessee, but most have a depauperate flora during the drier summer months. Dominant woody species include *Nyssa sylvatica, Acer rubrum, Liquidambar styraciflua, Itea virginica*, and *Viburnum nudum*. The herbaceous layer is characterized by *Osmunda cinnamomea, O. regalis, Woodwardia areolata, W. virginica, Carex intumescens, C. joorii, Lilium michiganense, Zigadenus leimanthoides, Platanthera ciliaris, P. clavellata, P. cristata, P. integrilabia, Isotria verticillata, Xyris torta, Rhynchospora corniculata, Juncus repens, Parnassia asarifolia, Prosperpinaca pectinata,* and *Aster umbellatus*. Taxa from this area that have affinities with the Coastal Plain, although not restricted to it, include *Woodwardia virginica, Juncus repens, Rhynchospora corniculata, Itea virginica,* and *Proserpinaca pectinata.*

Area 2, the north rim, and area 3, the south rim, include the relatively flat to rolling uplands of the surrounding Cumberland Plateau. Both areas are disturbed to varying degrees by logging and support a similar flora. In general, the vegetation of the regenerating forest is dominated by various species of *Quercus* and *Carya*. Other frequent trees and shrubs are *Pinus echinata, Oxydendrum arboreum, Calycanthus floridus, Nyssa sylvatica, Viburnum acerifolium, Rhododendron nudiflorum*, and *Vaccinium* spp. Occasional small streams that are perpendicular to the rim of the gorge support dense understory vegetation of *Kalmia latifolia, Tsuga canadensis, Ilex opaca,* and

Euonymus americanus. Several noteworthy herbs occur chiefly in the upland woods, namely, *Chamaelirium luteum, Cypripedium acaule, Malaxis unifolia,* and *Monotropsis odorata.* A small swamp on the extreme western end of the south rim is dominated by *Woodwardia virginica.* The distribution of this infrequent fern in Tennessee is discussed by Wofford, Webb, and Dennis (1977).

Area 4 represents the south facing slope of Savage Gulf. Extensive boulder fields with thick entanglements of *Parthenocissus quinquefolia* and *Rhus radicans* characterize much of the upper slope. The herbaceous flora is meager on these drier sites, but is relatively rich on more mesic sites near Savage Creek. A few of the more common spring wild flowers found on the lower slope are *Orchis spectabilis, Cyripedium calceolus* var. *pubescens, Hexastylis arifolia, Geranium maculatum, Sedum ternatum, Viola conspersa,* and *Phlox divaricata.* Quarterman *et al.* (1972) sampled the overstory on the south facing slope and found high importance values for *Quercus prinus* (85.4), *Carya tomentosa* (56.7), *Quercus rubra* (56.6), *Liriodendron tulipifera* (23.3), *Quercus alba* (23.0), *Carya ovata* (17.6), *Carya ovalis* (12.0), and *Pinus virginiana* (11.0). Furthermore, they consider this forest to be an oak-hickory-tuliptree expression of the mixed mesophytic forest type.

Area 5, the north facing slope of Savage Gulf, is the most floristically diverse area. The spring and early summer flora contain many elements of the hardwood forest of the Appalachian Mountains. Common among these are *Dryopteris intermedia, Disporum maculatum, Trillium erectum, Polygonatum pubescens, Aristolochia macrophylla, Claytonia caroliniana, Mitella diphylla, Viola blanda,* and *Chelone lyonii. Dryopteris goldiana, Athyrium pycnocarpon, Phacelia bipinnatifida,* and an occasional element more typical of the Interior Low Plateau and Central Lowland Provinces, such as *Trillium recurvatum* and *Stylophorum diphyllum,* are other features of Area 5. Two particularly northern elements, *Streptopus amplexifolius* and *Maianthemum canadense,* are reported by Quarterman *et al.* (1972), but were not observed in the present study and specimens have not been located.

Many co-dominants occupy the overstory of Area 5. Quarterman *et al.* (1972) report high importance values for *Tilia heterophylla* (61.7), *Tsuga canadensis* (54.4), *Acer saccharum* (40.0), *Liriodendron tulipifera* (37.6), *Aesculus octandra* (23.1), *Carya tomentosa* (20.8), *Fagus grandifolia* (17.1), *Quercus rubra* (12.6), and *Magnolia acuminata* (12.2). *Cladrastis lutea,* an uncommon tree of the eastern U.S., occurs sporadically in the understory. In addition, Quarterman *et al.* (1972) consider the north facing slope to more closely resemble Braun's (1950) typical mixed mesophytic forest of the Cumberland Mountains than adjacent mixed mesophytic stands in Tennessee.

Area 6 is defined as the mouth of Savage Gulf and consists of many habitats from flood plain woods to open, drier limestone outcrops. Savage Creek runs underground in the mouth of the Gulf, except for periods of high

rainfall when torrents may increase the water's height above ground by 10 to 15 ft. The flood plain woods is composed of cutover pines (*Pinus echinata* and *P. virginiana*), several oaks (*Quercus falcata, Q. alba, Q. rubra*), *Platanus occidentalis, Carpinus caroliniana, Crataegus* spp., and *Liquidambar styraciflua.* Characteristic shrubs along the bouldery channel are *Xanthorhiza simplicissima Dirca palustris, Ilex ambigua* var. *montana, Cornus amomum, Rhododendron arborescens,* and *Viburnum rufidulum.* Herbaceous taxa that occur in abundance include *Asplenium platyneuron, Pachysandra procumbens, Phlox glaberrima, P. maculata, Collinsonia canadensis, Mitchella repens,* and *Marshallia trinervia.* Other open habitats support a more weedy flora of many legumes and composites.

A noteworthy limestone site occurs at an elevation of 1250 to 1300 ft in a northwesterly exposure toward the mouth of Savage Gulf. Calciphiles of this site are *Agave virginica, Quercus muehlenbergii, Bumelia lycioides, Fraxinus quadrangulata, Swertia caroliniensis,* and *Echinacea purpurea.*

RARE TENNESSEE PLANTS[2]

Several rare Tennessee plants, designated as such by the Committee for Tennessee Rare Plants (1978), occur in Savage Gulf. These are listed below with their degree of endangerment in Tennessee and location within the study area.

1. *Woodwardia virginica* (L.) Smith—SPECIAL CONCERN. Dense colonies in swamp on extreme western edge of south rim, 14 May 1977, *Webb & Wofford 812*; upland swamp on north rim, 15 May 1977, *Webb &Wofford 819.*

2. *Poa languida* Hitchcock—SPECIAL CONCERN. Mouth of Gulf, flood plain, 26 Apr 1977, *Phillippe & Patrick 3769.*

3. *Carex pedunculata* Muhl.—SPECIAL CONCERN. Savage Gulf below still, under hemlock, 4 May 1977, *Kral 59910.*

4. *Veratrum woodii* Robbins—ENDANGERED. Savage Gulf, nw of Sewanee, Jul 1972, M. Rhinehart s.n.; north facing slope near western end of Gulf, 23 Jul 1977, *Patrick, Phillippe, & Simmers 289.* This taxon is genuinely rare in the Southeast (Johnson, 1969) and the Savage Gulf population of about 200 individuals is the only known Tennessee locality.

5. *Zigadenus leimanthoides* Gray—THREATENED. Locally abundant in upland swamp on north rim, 22 Jun 1977, *Wofford & Webb 77-90.*

6. *Platanthera integrilabia* (Correll) Luer—ENDANGERED. Locally abundant in upland swamp on north rim, 26 Jul 1977, *Wofford & Webb 77-219*; swale along old logging road on south rim, 23 Jul 1977, *Patrick, Phillippe, Wilson, & Simmers 300.*

[2] *Trichomanes petersii* Gray—ENDANGERED. Dr. David K. Smith recently collected specimens of this rare fern from the Gulf. Exact data and discussion of this report will appear separately.

7. *Cimicifuga rubifolia* Kearney—THREATENED. Near base of caprock on north facing slope, 23 Jul 1977, *Patrick, Phillippe, & Simmers 288.*

8. *Hydrastis canadensis* L.—THREATENED. Deciduous woods near flood plain on south side of Savage Creek, in mouth, 14 May 1977, *Patrick & Phillippe 83.*

9. *Panax quinquefolium* L.—THREATENED. Uncommon on north facing slope, 23 Jul 1977, *Patrick, Phillippe, & Simmers 281.*

10. *Montropsis odorata* Schweinitz in Ell.—THREATENED. Well-rotted wood along trail on north rim of Savage Gulf, ca. 0.5 mi W of Meadow Creek, elev. 1820 ft, 2 Apr 1977, *M. Whitten s.n.*; pine woods along foot trail on north rim near edge of gorge, 26 Apr 1977, *Wofford, Webb, & Rader 77-29.*

In addition, *Carex hitchcockiana* Dewey was collected from the base of the south rim on limestone near Savage Creek, 8 Jun 1977, *Patrick, Phillippe, & Malter 201.* Although this is the first collection on record in a Tennessee herbarium, Fernald (1950) and Underwood (1962) include this taxon for Tennessee. Another noteworthy record is the first verification of *Chelone lyonii* from the Cumberland Plateau.

BOTANICAL-ECOLOGICAL SIGNIFICANCE

Savage Gulf is one of the more floristically diverse natural areas in Tennessee. Considering the size of the area (ca. 10 sq. mi.), it contains an extremely high number of taxa (680) with elements from the Interior Low Plateau, the Appalachian Highlands, and the southeastern Coastal Plain. Several Tennessee rare plants occur here, including the only known locality for *Veratrum woodii* in the State. Furthermore, as noted by Quarterman *et al.* (1972), the forest that occurs on much of the north facing slope is an important virgin relic of mixed mesophytic forest.

The area is presently under the management of the Tennessee Heritage Program of the Tennessee Department of Conservation, as part of the Savage Gulf Natural Area. It is our recommendation to those responsible for maintaining the antiquity and botanical uniqueness of the area that any development be limited to primitive use. All concerned citizens must shoulder the responsibility to preserve yet another small piece of our natural heritage.

ACKNOWLEDGEMENTS

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FLORISTIC SUMMARY

Collections were made throughout the study area from mid-April through

October, 1977. Voucher specimens are deposited in the University of Tennessee Herbarium, Knoxville (TENN) and duplicates will be distributed at a later date.

A total of 680 taxa from 360 genera and 111 families is represented in the flora. For the most part, nomenclature is that of Radford, Ahles, & Bell (1968). Taxa are arranged alphabetically by family, genus, and species under three major headings, as follows: PTERIDOPHYTES (ferns and fern allies), GYMNOSPERMS, and ANGIOSPERMS. Number(s) after each entry refer to the general locality or plant community from which the voucher was collected. Slight records are not included. These areas are delimited in a preceding section, as follows:

1—Upland Swamp on North Rim
2—North Rim Woods
3—South Rim Woods
4—South Facing Slope
5—North Facing Slope
6—Mouth of Gulf

I. PTERIDOPHYTES

ADIANTACEAE

Adiantum pedatum L.—4
Cheilanthes lanosa (Michx.) D.C. Eaton—4
Pellaea atropurpurea (L.) Link—6

ASPLENIACEAE

Asplenium montanum Willd.—5
Asplenium platyneuron (L.) Oakes—3, 5, 6
Asplenium rhizophyllum L.—5
Athyrium asplenioides (Michx.) A. A. Eaton—1, 3
Athyrium pycnocarpon (Sprengel) Tidestrom—5
Athyrium thelypterioides (Michx.) Desvaux—5
Cystopteris bulbifera (L.) Bernh.—5
Cystopteris protrusa (Weatherby) Blasdell—4, 6
Dryopteris goldiana (Hooker) Gray—5
Dryopteris intermedia (Willd.) Gray—5
Dryopteris marginalis (L.) Gray—3, 4, 5
Polystichum acrostichoides (Michx.) Schott—4
Thelypteris hexagonoptera (Michx.) Weatherby—5
Thelypteris noveboracensis (L.) Nieuwland—3, 5

BLECHNACEAE

Woodwardia areolata (L). Moore—1
Woodwardia virginica (L.) Smith—1, 3

DENNSTAEDIACEAE

Dennstaedtia punctilobula (Michx.) Moore—3,5
Pteridium aquilinum L.—2

HYMENOPHYLLACEAE

Trichomanes petersii Gray—4

LYCOPDIACEAE

Lycopodium lucidulum Michx.—5
Lycopodium obscurum L.—2, 3
Lycopodium porophilum Lloyd & Underwood—4
Lycopodium tristachyum Pursh—2, 3

OPHIOGLOSSACEAE

Botrychium dissectum Sprengel—3, 5, 6
Botrychium virginianum (L.) Swartz—4, 5

OSMUNDACEAE

Osmunda cinnamomea L.—3
Osmunda regalis (Willd.) Gray—1

POLYPODIACEAE

Polypodium polypodioides (L.) Watt—5
Polypodium virginianum L.—5

SCHIZAEACEAE

Lygodium palmatum (Bernh.) Swartz —2

SELAGINELLACEAE

Selaginella apoda (L.) Spring—4

VITTARIACEAE

Vittaria sp. (gametophyte)—5

II. GYMNOSPERMS

PINACEAE

Pinus echinata Miller—3
Pinus taeda L.—3
Pinus virginiana Miller—2, 3, 4
Tsuga canadensis (L.) Carr.—5

CUPRESSACEAE

Juniperus virginiana L.—3

III. ANGIOSPERMS

ACANTHACEAE

Ruellia caroliniensis (Walt.) Steud.—6

ACERACEAE

Acer negundo L.—3
Acer pensylvanicum L.—5
Acer rubrum L.—3
Acer saccharum Marsh.—5

ALISMATACEAE

Alisma subcordatum Raf.—2
Sagittaria latifolia Willd.—2, 6
Sagittaria engelmanniana J. G. Smith ssp. longirostra (Micheli) Bogin—3

AMARYLLIDCEAE

Agave virginica L.—6
Hypoxis hirsuta (L.) Coville—3, 6

ANACARDIACEAE

Rhus copallina L.—3
Rhus glabra L.—6
Rhus radicans L.—4

ANNONACEAE

Asimina triloba (L.) Dunal—5

APIACEAE

Angelica venenosa (Greenway) Fern.—3
Chaerophyllum tainturieri Hooker—6
Cicuta maculata L.—4
Cryptotaenia canadensis (L.) DC.—6
Daucus carota L.—6
Erigenia bulbosa (Michx.) Nutt.—5
Eryngium yuccifolium Michx.—3
Ligusticum canadense (L.) Britt.—6
Osmorhiza claytonii (Michx.) Clarke —5, 6
Oxypolis rigidior (L.) Raf.—1, 3
Sanicula canadensis L.—3, 5
Sanicula gregaria Bicknell—5
Sanicula smallii Bicknell—4
Sanicula trifoliata Bicknell—5
Taenidia integerrima (L.) Drude—6
Thaspium barbinode (Michx.) Nutt.—4, 5
Zizia aptera (Gray) Fern.—6

AQUIFOLIACEAE

Ilex ambigua (Michx.) Torr. var. montana (T. & G.) Ahles—2, 3, 6
Ilex decidua Walt.—6
Ilex opaca Ait.—3, 4

ARACEAE

Arisaema triphyllum (L.) Schott—4, 5

ARALIACEAE

Aralia racemosa L.—6
Aralia spinosa L.—3, 6
Panax quinquefolium L.—5

ARISTOLOCHIACEAE

Aristolochia macrophylla Lam.—5
Aristolochia serpentaria L.—5
Asarum canadense L.—5
Hexastylis arifolia (Michx.) Small—2, 4

ASCLEPIADACEAE

Asclepias amplexicaulis Smith—3
Asclepias quadrifolia Jacq.—4, 5
Asclepias tuberosa L.—3
Asclepias variegata L.—3
Matelea carolinensis (Jacq.) Woodson —6

ASTERACEAE

Ambrosia artemisiifolia L.—3
Ambrosia trifida L.—6
Antennaria plantaginifolia (L.) Hook. —3
Antennaria solitaria Rydb.—4
Aster cordifolius L.—6
Aster divaricatus L.—3, 5, 6

Aster dumosus L.—2
Aster infirmus Michx.—3
Aster laevis L.—6
Aster lateriflorus (L.) Britt.—4, 6
Aster linariifolius L.—3
Aster lowrieanus Porter—3
Aster patens Ait.—3
Aster paternus Cronquist—2, 3
Aster shortii Lindl.—2, 6
Aster simplex Willd.—3
Aster solidagineus Michx.—3
Aster surculosus Michx.—2, 3
Aster umbellatus Mill.—1, 6
Bidens bipinnata L.—6
Bidens frondosa L.—2
Bidens polylepis Blake—3
Cacalia atriplicifolia L.—6
Chrysanthemum leucanthemum L.—3
Cirsium altissimum (L.) Sprengel—2
Cirsium muticum Michx.—6
Coreopsis auriculata L.—6
Coreopsis major Walt. var. stellata (Nutt.) Robinson—3
Echinacea purpurea (L.) Moench—6
Elephantopus carolinianus Willd.—6
Elephantopus tomentosus L.—6
Erechtites hieracifolia (L.) Raf.—2, 3, 6
Erigeron annuus (L.) Pers.—3
Erigeron canadensis L.—6
Erigeron pulchellus Michx.—4
Erigeron strigosus Muhl. ex Willd.—3
Eupatorium album L.—3
Eupatorium aromaticum L.—3
Eupatorium hyssopifolium L.—3
Eupatorium incarnatum Walt.—6
Eupatorium perfoliatum L.—3
Eupatorium purpureum L.—3, 5, 6
Eupatorium rotundifolium L.—3
Eupatorium rugosum Houtt.—6
Eupatorium serotinum Michx.—3
Gnaphalium helleri Britt.—3
Gnaphalium obtusifolium L.—3
Gnaphalium purpureum L.—4
Helenium autumnale L.—3
Helianthus atrorubens L.—3
Helianthus decapetalus L.—6
Helianthus hirsutus Raf.—6
Helianthus microcephalus T. & G.—6
Heliopsis helianthoides (L.) BSP—4, 6
Heterotheca graminifolia (Michx.) Shinners—3
Heterotheca mariana (L.) Shinners—2, 3
Hieracium gronovii L.—2, 3
Hieracium paniculatum L.—3
Hieracium venosum L.—3, 4
Krigia biflora (Walt.) Blake—3, 6
Lactuca canadensis L.—6
Lactuca floridana (L.) Gaertn.—6
Liatris aspera Michx.—3
Liatris microcephala (Small) K. Schumann—2
Liatris spicata (L.) Willd.—3
Marshallia trinervia (Walt.) Trelease ex Branner & Coville—6
Parthenium integrifolium L.—3
Polymnia canadensis L.—4, 5
Polymnia uvedalia L.—6
Prenanthes altissima L.—3, 6
Prenanthes serpentaria Pursh—3
Pyrrhopappus carolinianus (Walt.) DC.—6
Rudbeckia fulgida Ait. var. umbrosa (Boynton & Beadle) Cronquist—6
Rudbeckia hirta L.—3, 6
Rudbeckia laciniata L.—3, 6
Senecio aureus L.—6
Senecio obovatus Muhl. ex Willd.—4
Senecio smallii Britt.—3
Silphium trifoliatum L.—6
Solidago arguta Ait.—3
Solidago boottii Hook. var. boottii—6
Solidago boottii Hook. var. caroliniana (Gray) Cronquist—3
Solidago caesia L.—6
Solidago canadensis L. var. scabra (Muhl.) T. & G.—3, 6
Solidago curtisii T. & G.—3
Solidago erecta Pursh—2, 3, 6
Solidago flexicaulis L.—6
Solidago gigantea Ait.—2, 6
Solidago graminifolia (L.) Salisb. var. nuttallii (Greene) Fern.—2
Solidago hispida Muhl.—3
Solidago nemoralis Ait.—3
Solidago odora Ait.—2, 3, 6
Solidago roanensis Porter—6
Solidago rugosa Mill. ssp. aspera (Ait.) Cronquist—2, 6
Solidago ulmifolia Muhl.—3, 6
Taraxacum officinale Wiggers—6
Verbesina alternifolia (L.) Britt.—6
Vernonia altissima Nutt.—6

BALSAMINACEAE

Impatiens capensis Meerb.—6
Impatiens pallida Nutt.—5

BERBERIDACEAE

Caulophyllum thalictroides (L.) Michx.—5
Podophyllum peltatum L.—5

BETULACEAE

Alnus serrulata (Ait.) Willd.—2
Betula lutea Michx. f.—4, 5
Betula nigra L.—2
Carpinus caroliniana Walt.—6
Corylus americana Walt.—6
Ostrya virginiana (Mill.) K. Koch—5

BIGNONIACEAE

Anisostichus capreolata (L.) Bureau—4, 6
Campsis radicans (L.) Seemann—6
Paulownia tomentosa (Thunb.) Steud.—6

BORAGINACEAE

Cynoglossum virginianum L.—4
Lithospermum tuberosum Rugel ex DC.—4

BRASSICACEAE

Arabis canadensis L.—6
Arabis leavigata (Muhl. ex Willd.) Poir.—4, 6
Cardamine hirsuta L.—6
Dentaria laciniata Muhl.—5

BUXACEAE

Pachysandra procumbens Michx.—6

CALYCANTHACEAE

Calycanthus floridus L.—4

CAMPANULACEAE

Campanula americana L.—6
Lobelia cardinalis L.—6
Lobelia inflata L.—2, 3
Lobelia puberula Michx.—6
Specularia perfoliata (L.) DC.—3, 6

CAPRIFOLIACEAE

Lonicera japonica Thunb.—6
Lonicera sempervirens L.—3
Sambucus canadensis L.—6
Sambucus pubens Michx.—5
Triosteum perfoliatum L.—3
Viburnum acerifolium L.—2
Viburnum cassinoides L.—2
Viburnum dentatum L.—3
Viburnum nudum L.—2, 3
Viburnum rufidulum Raf.—2, 6

CARYOPHYLLACEAE

Cerastium holosteoides Fries var. vulgare (Hartman) Hylander—6
Silene rotundifolia Nutt.—4, 5
Silene stellata (L.) Ait. f.—3
Silene virginica L.—4
Stellaria pubera Michx.—5

CELASTRACEAE

Euonymus americanus L.—5, 6
Euonymus atropurpureus Jacq.—6

CISTACEAE

Lechea racemulosa Michx.—3, 6

COMMELINACEAE

Tradescantia subaspera Ker—6

CONVOLULACEAE

Calystegia spithamaea (L.) R. Brown—6
Cuscuta campestris Yuncker—6
Cuscuta compacta Juss.—3
Ipomoea purpurea (L.) Roth—6

CORNACEAE

Cornus alternifolia L. f.—5
Cornus amomum Mill.—6
Cornus florida L.—5

CRASSULACEAE

Sedum ternatum Michx.—4

CYPERACEAE

Carex aestivalis M. A. Curtis—3, 6
Carex albolutescens Schwein.—3
Carex albursina Sheldon—3
Carex amphibola Steud.—2
Carex austro-caroliniana Bailey—4
Carex baileyi Britt.—3
Carex cephalophora Muhl. ex Schkuhr—3
Carex communis Bailey—2, 4
Carex complanata Torr. & Hook.—3
Carex crinita Lam.—3
Carex debilis Michx. var. rudgei Bailey—1, 2, 3
Carex emmonsii Dewey—5
Carex flaccosperma Dewey—1
Carex gigantea Rudge—1
Carex hitchcockiana Dewey—6

Carex incomperta Bicknell—3
Carex intumescens Rudge—1, 2, 3
Carex jamesii Schwein.—6
Carex joorii Bailey—1
Carex laxiflora Lam.—3, 5
Carex lurida Wahl.—3
Carex pedunculata Muhl.—5
Carex pensylvanica Lam. var. distans Peck—4
Carex plantaginea Lam.—5
Carex purpurifera Mackenzie—2, 4, 5
Carex retroflexa Muhl. ex Schkuhr—6
Carex rosea Schkuhr—2
Carex swanii (Fern.) Mackenzie—2, 3, 6
Carex virescens Muhl. ex Schkuhr—2, 3, 6
Cyperus praelongatus Steud.—6
Cyperus retrofractus (L.) Torr.—3
Cyperus strigosus L.—6
Eleocharis obtusa (Willd.) Schultes—3
Rhynchospora capitellata (Michx.) Vahl—3, 5
Rhynchospora corniculata (Lam.) Gray—1
Scirpus atrovirens Willd. var. georgianus (Harper) Fern.—3, 6
Scirpus cyperinus (L.) Kunth—1
Scleria oligantha Michx.—6
Scleria triglomerata Michx.—3

DIOSCOREACEAE

Dioscorea batatas Dcne.—6
Dioscorea villosa L.—4, 6

EBENACEAE

Diospyros virginiana L.—3

ERICACEAE

Chimaphila maculata (L.) Pursh—6
Epigaea repens L.—3, 4, 6
Kalmia latifolia L.—2, 3, 4
Lyonia ligustrina (L.) DC.—3
Monotropa hypopithys L.—3
Monotropa uniflora L.—6
Monotropsis odorata Schwein. in Ell.—2
Oxydendrum arboreum (L.) DC.—3
Rhododendron alabamense Rehder—1, 3
Rhododendron arborescens (Pursh) Torr.—6
Rhododendron calendulaceum (Michx.) Torr.—3
Rhododendron cumberlandense Braun—3
Rhododendron maximum L.—5
Rhododendron nudiflorum (L.) Torr.—3, 4
Vaccinium arboreum Marsh.—2
Vaccinium constablaei Gray—2, 4
Vaccinium corymbosum L.—3
Vaccinium stamineum L.—3
Vaccinium vacillans Torr.—3, 4

EUPHORBIACEAE

Acalypha gracilens Gray—3
Acalypha rhomboidea Raf.—6
Croton monanthogynus Michx.—3
Euphorbia corollata L. var. zinniiflora (Small) Ahles—3
Euphorbia mercurialina Michx.—4

FABACEAE

Albizia julibrissin Durazzini—3
Amphicarpa bracteata (L.) Fern.—6
Apios americana Medicus—3
Baptisia tinctoria (L.) R. Brown—2, 3
Cassia marilandica L.—6
Cassia nictitans L.—6
Cercis canadensis L.—6
Cladrastis lutea (Michx. f.) K. Koch—5
Clitoria mariana L.—3
Desmodium cuspidatum (Muhl. ex Willd.) Loudon—6
Desmodium glutinosum (Muhl. ex Willd.) Wood—6
Desmodium marilandicum (L.) DC.—3
Desmodium nudiflorum (L.) DC.—2, 6
Desmodium paniculatum (L.) DC. var. paniculatum—2, 6
Desmodium paniculatum (L.) DC. var. dillenii (Darl.) Isely—3, 6
Desmodium obtusum (Muhl. ex Willd.) DC.—6
Desmodium pauciflorum (Nutt.) DC.—6
Desmodium rotundifolium DC.—6
Galactia volubilis (L.) Britt.—6
Lespedeza bicolor Turcz.—3
Lespedeza cuneata (Dumont) G. Don—3
Lespedeza hirta (L.) Hornemann—2, 3
Lespedeza hirta X intermedia—2, 3
Lespedeza intermedia (S. Wats.) Britt.—3, 6

Lespedeza repens (L.) Bart.—3
Lespedeza steuvei Nutt.—3
Melilotus alba Desr.—3
Psoralea psoralioides (Walt.) Cory—4
Robinia (hybrid)—2
Robinia pseudo-acacia L.—4
Schrankia microphylla (Soland. ex Sm.) Mcbride—3
Stylosanthes biflora (L.) BSP.—3
Tephrosia virginiana (L.) Pers.—2, 3
Trifolium campestre Schreb.—6
Trifolium pratense L.—6
Vicia caroliniana Walt.—6

FAGACEAE

Castanea dentata (Marsh.) Borkh.—3, 4
Fagus grandifolia Ehrhart—2
Quercus alba L.—3
Quercus coccinea Meunchh.—3
Quercus falcata Michx.—3
Quercus marilandica Muenchh.—3
Quercus muehlenbergii Engelm.—6
Quercus prinus L.—3
Quercus rubra L.—3
Quercus stellata Wang.—3
Quercus velutina Lam.—3

FUMARIACEAE

Dicentra cucullaria (L.) Bernh.—5

GENTIANACEAE

Bartonia virginica (L.) BSP.—1, 3
Gentiana quinquefolia L.—4, 6
Gentiana saponaria L.—1, 3
Gentiana villosa L.—2, 3
Sabatia brachiata Ell.—3
Swertia caroliniensis (Walt.) Kuntze—6

GERANIACEAE

Geranium carolinianum L.—6
Geranium maculatum L.—4

HALORATACEAE

Proserpinaca pectinata Lam.—1

HAMAMELIDACEAE

Hamamelis virginiana L.—2, 5
Liquidambar styraciflua L.—4, 6

HIPPOCASTANACEAE

Aesculus octandra Marsh.—5, 6

HYDROPHYLLACEAE

Hydrophyllum canadense L.—5
Phacelia bipinnatifida Michx.—5

HYPERICACEAE

Hypericum denticulatum Walt. var. recognitum Fern. & Schub.—3
Hypericum gentianoides (L.) BSP.—2, 3
Hypericum mutilum L.—3
Hypericum nudiflorum Michx. ex Willd.—6
Hypericum prolificum L.—6
Hypericum punctatum Lam.—2, 6
Hypericum stans (Michx.) P. Adams & Robson—3
Hypericum stragalum P. Adams & Robson—3, 6

IRIDACEAE

Iris cristata Ait.—4, 5
Sisyrinchium albidum Raf.—6
Sisyrinchium angustifolium Mill.—6

JUGLANDACEAE

Carya cordiformis (Wang.) K. Koch—5
Carya glabra (Mill.) Sweet—6
Carya ovalis (Wang.) Sarg.—6
Carya ovata (Mill.) K. Koch—5
Carya pallida (Ashe) Engler & Graebn.—3
Carya tomentosa (Poir.) Nutt.—6
Juglans cinerea L.—6
Juglans nigra L.—6

JUNCACEAE

Juncus canadensis J. Gay ex La Harpe—3
Juncus coriaceus Mackenzie—3
Juncus debilis Gray—1, 3
Juncus effusus L.—1, 3
Juncus marginatus Rostk.—3
Juncus repens Michx.—1
Juncus tenuis Willd.—2, 3
Luzula acuminata L.—6
Luzula bulbosa (Wood) Rydb.—3

LAMIACEAE

Collinsonia canadensis L.—6
Dracocephalum virginianum L.—6
Lycopus virginicus L.—2, 3, 6
Monarda clinopodia L.—4, 6
Mosla dianthera (Hamilton) Michx.—6
Perilla frutescens (L.) Britt.—6
Prunella vulgaris L.—3

Pycnanthemum incanum (L.) Michx.—6
Pycnanthemum muticum (Michx.) Pers.—3
Salvia lyrata L.—6
Salvia urticifolia L.—6
Scutellaria elliptica Muhl.—3, 6
Scutellaria pseudoserrata Epling—6
Trichostema dichotomum L.—6

LAURACEAE

Lindera benzoin (L.) Blume—2, 5
Sassafras albidum (Nutt.) Nees—4

LILIACEAE

Aletris farinosa L.—3
Allium canadense L.—6
Chamaelirum luteum (L). Gray—3
Disporum lanuginosum (Michx.) Nicholson—5
Disporum maculatum (Buckl.) Britt.—5
Erythronium americanum Ker—6
Lilium michiganense Farw.—1
Medeola virginiana L.—2
Polygonatum biflorum (Walt.) Ell.—3
Polygonatum pubescens (Willd.) Pursh—5
Smilacina racemosa (L.) Desf.—4
Smilax bona-nox L.—6
Smilax ecirrhata (Engelm.) Watson var. hugeri (Small) Ahles—4, 5, 6
Smilax glauca Walt.—3, 4
Smilax hispida Muhl.—6
Smilax rotundifolia L.—3, 4, 6
Trillium cuneatum Raf.—5, 6
Trillium erectum L.—5
Trillium grandiflorum (Michx.) Salisb.—5
Trillium recurvatum Beck—5
Uvularia grandiflora Smith—5, 6
Uvularia perfoliata L.—6
Uvularia sessilifolia L.—2, 3
Veratrum woodii Robbins—5
Zigadenus leimanthoides Gray—1

LINACEAE

Linum striatum Walt.—2, 3
Linum virginianum L. var. floridanum Planchon—3

LOGANIACEAE

Spigelia marilandica L.—6

LORANTHACEAE

Phoradendron serotinum (Raf.) M. C. Johnston—5

MAGNOLIACEAE

Lirodendron tulipifera L.—4
Magnolia acuminata L.—4
Magnolia tripetala L.—6

MALVACEAE

Hibiscus syriacus L.—6

MELASTOMATACEAE

Rhexia mariana L.—3
Rhexia virginica L.—3

MORACEAE

Morus rubra L.—6

NYSSACEAE

Nyssa sylvatica Marsh.—4, 5

OLEACEAE

Chionanthus virginicus L.—3
Ligustrum vulgare L.—5
Fraxinus americana L. var. biltmoreana (Beadle) J. Wright ex Fern.—6
Fraxinus quadrangulata Michx.—6

ONAGRACEAE

Circaea lutetiana L. ssp. canadensis (L.) Aschers. & Magnus—6
Ludwigia alternifolia L.—2, 3
Oenothera biennis L.—6
Oenothera tetragona Roth—3

ORCHIDACEAE

Aplectrum hyemale (Muhl. ex Willd.) Torr.—5
Corallorhiza odontorhiza (Willd.) Nutt.—3, 6
Cypripedium acaule Ait.—2
Cypripedium calceolus L. var. pubescens (Willd.) Correll—4
Goodyera pubescens (Willd.) R. Brown—3
Hexalectris spicata (Walt.) Barnhart—6
Isotria verticillata (Muhl. ex Willd.) Raf.—1
Malaxis unifolia Michx.—2, 3
Orchis spectabilis L.—4
Platanthera ciliaris (L.) Lindely—1, 3

Platanthera clavellata (Michx.) Luer—1, 3
Platanthera cristata (Michx.) Lindley—1
Platanthera integrilabia (Correll) Luer—1, 3
Tipularia discolor (Pursh) Nutt.—6
Triphora trianthophora (Swartz) Rydb. 5

OROBANCHACEAE

Conopholis americana (L.) Wallroth—4
Epifagus virginiana (L.) Barton—5, 6

OXALIDACEAE

Oxalis dillenii Jacq.—6
Oxalis stricta L.—6
Oxalis violacea L.—6

PAPAVERACEAE

Sanguinaria canadensis L.—5
Stylophorum diphyllum (Michx.) Nutt.—5

PASSIFLORACEAE

Passiflora lutea L.—6

PHRYMACEAE

Phryma leptostachya L.—4

PHYTOLACCACEAE

Phytolacca americana L.—6

PLANTAGINACEAE

Plantago aristata Michx.—3
Plantago lanceolata L.—3
Plantago rugelii Dcne.—6
Plantago virginica L.—6

PLATANACEAE

Platanus occidentalis L.—4, 6

POACEAE

Agrostis perennans (Walt.) Tuckerman 2, 3, 6
Andropogon gerardii Vitman—3
Andropogon scoparius Michx.—2, 3
Andropogon virginicus L.—6
Aristida dichotoma Michx.—3
Arundinaria gigantea (Walt.) Muhl.—6
Brachyelytrum erectum (Schreb.) Beauv.—6
Bromus purgans L.—6
Bromus secalinus L.—2
Calamogrostis cinnoides (Muhl.) Bart. 1, 3
Chasmanthium latifolium (Michx.) Yates—6
Chasmanthium laxum (L.) Yates—3
Cinna arundinacea L.—6
Dactylis glomerata L.—3
Danthonia compressa Austin—3
Danthonia serivea Nutt.—2
Danthonia spicata (L.) Beauv. ex R. & S.—6
Deschampsia flexuosa (L.) Trin.—2, 3
Diarrhena americana Beauv.—6
Digitaria ischaemum (Schreb.) Schreb. ex Muhl. var. ischaemum—3
Digitaria ischaemum (Schreb.) Schreb. ex Muhl. var. violascens (Link) Radford—3
Echinochloa muricata (Beauv.) Fern.—3
Eleusine indica (L.) Gaertner—3
Elymus virginicus L.—3
Eragrostis spectabilis (Pursh) Steudel—3
Erianthus alopecuroides (L.) Ell.—6
Festuca elatior L.—3
Festuca obtusa Biehler—6
Holcus lanatus L.—3
Hystrix patula Moench—6
Leersia virginica Willd.—3, 6
Lolium multiflorum Lam.—3
Melica mutica Walt.—2, 4
Microstegium vimineum (Trin.) A. Camus—3
Muhlenbergia schreberi J. F. Gmelin—3
Muhlenbergia sylvatica (Torr.) Torr. ex Gray—6
Panicum anceps Michx.—3
Panicum boscii Poir.—2, 6
Panicum clandestinum L.—3
Panicum dichotomum L.—1, 3
Panicum laxiflorum Lam.—3, 6
Panicum longifolium Torr.—1
Panicum longiligulatum Nash—1
Panicum philadelphicum Bernh.—3
Panicum polyanthes Schult.—2
Panicum sphaerocarpon Ell.—3
Paspalum laeve Michx.—3
Poa compressa L.—3
Poa languida Hitchc.—6
Poa pratensis L.—6

Setaria faberi W. Herrmann—3
Setaria geniculata (Lam.) Beauv.—3
Sorghastrum nutans (L.) Nash—3
Sphenopholis nitida (Biehler) Scribner—4
Sporobolus vaginiflorus (Torr.) Wood—3
Stipa avenacea L.—2, 6
Tridens flavus (L.) Hitchc.—6

POLEMONIACEAE

Phlox amoena Sims—2
Phlox carolina L.—6
Phlox divaricata L.—4, 5, 6
Phlox glaberrima L.—6
Phlox maculata L. ssp. pyramidalis (Smith) Wherry—2, 6
Phlox pilosa L.—6

POLYGALACEAE

Polygala curtissii Gray—3
Polygala incarnata L.—3
Polygala senega L.—4
Polygala verticillata L.—2, 3

POLYGONACEAE

Polygonum cespitosum Blume var. longisetum (DeBruyn) Stewart—6
Polygonum persicaria L.—6
Polygonum punctatum Ell.—6
Polygonum scandens L.—6
Rumex acetosella L.—6
Rumex crispus L.—6
Tovara virginiana (L.) Raf.—6

PORTULACACEAE

Claytonia caroliniana Michx.—5

PRIMULACEAE

Lysimachia lanceolata Walt.—6
Lysimachia quadrifolia L.—3, 6
Lysimachia tonsa (Wood) Kunth—6

RANUNCULACEAE

Actaea pachypoda Ell.—5
Anemone quinquefolia L.—6
Anemone virginiana L.—6
Aquilegia canadensis L.—4
Cimicifuga rubifolia Kearney—5
Clematis virginiana L.—6
Delphinium tricorne Michx.—5
Hepatica acutiloba DC.—5
Hydrastis canadensis L.—6
Ranunculus abortivus L.—6
Ranunculus recurvatus Poir.—5
Thalictrum clavatum DC.—4, 5
Thalictrum pubescens Pursh—6
Thalictrum thalictroides (L.) Boivin—5, 6
Xanthorhiza simplicissima Marsh.—2, 6

RHAMNACEAE

Ceanothus americanus L.—6
Rhamnus caroliniana Walt.—6

ROSACEAE

Agrimonia parviflora Ait.—6
Agrimonia pubescens Wallroth—6
Agrimonia rostellata Wallroth—6
Amelanchier canadensis (L.) Medicus—3, 6
Aruncus dioica (Walt.) Fern.—6
Crataegus crus-galli L.—6
Crataegus flabellata (Bosc) K. Koch—3
Crataegus flava Ait.—4
Crataegus viridis L.—6
Geum canadense Jacq.—6
Gillenia stipulata (Muhl.) Baillon—6
Gillenia trifoliata (L.) Moench—3
Physocarpus opulifolius (L.) Maxim.—6
Potentilla canadensis L.—2
Potentilla norvegica L.—6
Potentilla simplex Michx.—3, 4
Prunus americana Marsh.—3, 4, 6
Prunus serotina Ehrh.—2, 6
Pyrus angustifolia Ait.—2, 3, 6
Pyrus arbutifolia (L.) L. f.—3
Pyrus melanocarpa (Michx.) Schneid.—6
Rosa carolina L.—5, 6
Rosa multiflora Thunb.—6
Rubus argutus Link—3, 6
Rubus betulifolius Small—3
Rubus hispidus L.—2, 3
Rubus occidentalis L.—4
Rubus phoenicolasius Maxim.—6
Spiraea japonica L.—6

RUBIACEAE

Cephalanthus occidentalis L.—3
Diodia teres Walt.—3
Diodia virginiana L.—6
Galium aparine L.—6
Galium circaezans Michx.—3, 6
Galium latifolium Michx.—5
Galium pilosum Ait.—3, 6

Galium triflorum Michx.—3, 6
Houstonia caerulea L.—2, 3
Houstonia purpurea L.—6
Mitchella repens L.—5, 6

SALICACEAE

Salix humilis Marsh.—3
Salix nigra Marsh.—3, 6

SANTALACEAE

Pyrularia pubera Michx.—6

SAPOTACEAE

Bumelia lycioides (L.) Pers.—6

SAXIFRAGACEAE

Astilbe biternata (Vent.) Britt.—5
Heuchera americana L.—5, 6
Heuchera praviflora Bartling—5
Heuchera villosa Michx.—5
Hydrangea arborescens L. ssp. discolor (Seringe) McClintock—5
Itea virginica L.—1, 2
Mitella diphylla L.—5
Parnassia asarifolia Vent.—1, 3
Penthorum sedoides L.—6
Tiarella cordifolia L.—5

SCROPHULARIACEAE

Agalinis tenuifolia (Vahl) Raf.—2, 3
Aureolaria laevigata (Raf.) Raf.—6
Aureolaria virginica (L.) Pennell—3
Chelone glabra L.—3
Chelone lyonii Pursh—6
Gratiola virginiana L.—3
Lindernia dubia (L.) Pennell—6
Mimulus alatus Ait.—6
Pedicularis canadensis L.—4
Penestemon canescens (Britt.) Britt. ssp. brevisepalus (Pennell) Crosswhite—6
Verbascum blattaria L.—6
Verbascum thapsus L.—3

SIMAROUBACEAE

Ailanthus altissima (Mill.) Swingle—5

SOLANACEAE

Physalis heterophylla Nees—6
Solanum carolinese L.—3, 6

THEACEAE

Stewartia ovata (Cav.) Weatherby—4, 6

THYMELAEACEAE

Dirca palustris L.—6

TILIACEAE

Tilia heterophylla Vent.—5

TYPHACEAE

Typha latifolia L.—3

ULMACEAE

Celtis occidentalis L.—6
Ulmus alata Michx.—6
Ulmus americana L.—5
Ulmus rubra Muhl.—4

URTICACEAE

Boehmeria cylindrica (L.) Swartz—2, 6
Laportea canadensis (L.) Weddell—5, 6
Pilea pumila (L.) Gray—6

VERBENACEAE

Verbena simplex Lehmann—3
Verbena urticifolia L.—6

VIOLACEAE

Hybanthus concolor (Forster) Sprengel—5
Viola affinis LeConte—4, 5, 6
Viola blanda Willd.—5
Viola canadensis L.—5
Viola conspersa Reichenb.—4, 5, 6
Viola hastata Michx.—5
Viola hirsutula Brainerd—2
Viola pedata L.—2, 3
Viola pensylvanica Michx.—5
Viola primulifolia L.—2, 3
Viola rostrata Pursh.—5
Viola triloba Schwein.—5

VITACEAE

Parthenocissus quinquefolia (L.) Planch.—4, 5
Vitis aestivalis Michx.—3, 4, 6
Vitis cinerea Engelm. ex Millardet—4
Vitis rotundifolia Michx.—4

XYRIDACEAE

Xyris torta Smith—1

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A NEW SPECIES OF *CENTROSEMA* (LEGUMINOSAE) FROM NICARAGUA AND A KEY TO THE SPECIES IN CENTRAL AMERICA[1]

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Seymour (1978a) reports four new species of *Centrosema* from Nicaragua, *viz. C. angustifolium* (H.B.K.) Benth., *C. plumieri* (Turp.) Benth., *C. pubescens* Benth, and *C. virginianum* (L.) Benth. However, a specimen of this genus deposited at the herbarium in Paris (P) which was examined in the course of a monographic study of the genus *Clitoria* (Fantz, 1977), does not accord with these or any other previously described species reported from Central America as listed in revisions and New World floras (e.g. Bentham, 1837, 1839; Standley, 1928; Standley and Record, 1936; Standley and Steyermark, 1946). The new species has larger flowers and bracteoles similar to *C. plumieri*, but is easily distinguished by the leaflet shape, longer calyx lobes, and the failure of the plant to turn black when dried.

Nicaragua, the largest country in Central America, has but one published flora (Ramírez Goyena, 1909–1911), which is reported to be of little value (Blake and Atwood, 1942). A retired minister and botanist, Frank C. Seymour, at the age of seventy-three, began a personal cataloguing of the Flora of Nicaragua in 1968. He made seven expeditions to Nicaragua to study the flora firsthand and to collect representative specimens, plus purchasing a number of Nicaraguan collections made by other scientists doing research in that country. This project was financed from Seymour's own personal funds and through the sale of duplicate herbarium specimens. Seymour (1978b) summarized his several publications on his expeditions and on the flora of Nicaragua. Now an octogenerian, Seymour's research is culminating in a manuscript which provides a checklist of the flora of Nicaragua. This new species of *Centrosema* is named in honor of Frank C. Seymour in recognition of his contribution to the botanical knowledge of Nicaragua.

CENTROSEMA **seymourianum** Fantz, sp. nov.

Folia trifoliata, *glabrata; foliola elliptico-oblonga*, breviacuminata, infra sparsim

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[1] Taxonomic studies accomplished at the IFAS Herbarium, Dept. of Botany, University of Florida, Gainesville, Florida. Florida Agricultural Experiment Station Journal Series No. 1327.

SIDA 8(2): 152–156. 1979.

puberula trichomatibus appressis secus nervos majories. Pedunculi axillares, plurifloribus apicem pedunculorum congestis. *Flores grandes*, resupinati, *5.5–6 cm longi*; vexillum extus sericeo-villosum. *Bracteolae elongatae, calycem subaequantes, 10–20 mm longae*, 4–5 *mm latae*. Calyx late campanulatus, tubo 4–5 mm longa; *dentes superi et laterales tubo vix longiores*, 5–7 mm longi; *dens ventralis elongatus*, 13–15 mm longus; *calycis pubescentia inconspicua*, in dente ventrali densior, *trichomatibus uncinatis*. Legumen incognitum.

Scandent herb; stems terete, faintly angular, longitudinally striated, hollow, 2–3 mm thick, weakly twining, pubescence scattered, pilose and uncinate (observed latter at 30X). *Leaves* 3-foliolate, petiolate, glabrate; leaflets pinnate, broadly elliptic-oblong, rapidly short-acuminate, apex mucronate, base rotund, primary nerves of 10–12 pairs, upper surface green, glabrous, lower surface concolorous, very sparsely pubescent with appressed trichomes along major nerves, lamina 12–13.5 cm long, 6–8 cm wide. Petioles subquangular-terete, densely pilose on pulvinus, sparsely so above, 5 cm long; rachis similar, ca 2.5 cm; petiolules quadrangular, pilose, 6–8 mm. Stipules ovate, striate, persistent, 4–6 mm long, 0.6–0.8 mm wide; stipels to 6 mm long. *Inflorescence* axillary, shorter than the petioles, several-flowered crowded at the apex of the peduncle; peduncles one or two per node, 2–2.5 cm. long, moderately densely pubescent, trichomes short, subappressed; pedicels paired, 8–9 mm. Bracts deciduous, ovate, striate, 6–7 mm long, 2–3 mm wide. Bracteoles enclosing calyx and flower in bud, large, coriaceous, striated, ovate-oblong, ciliolate, 10–12 mm long, 4–5 mm wide. *Flowers* large, papilionaceous, resupinate, 5.5–6 cm long. Calyx broadly campanulate, upper teeth widely separated from lateral and lower teeth, sparsely pubescent on tube but more densely on teeth, particularly the ventral tooth, trichomes uncinate, inconspicuous (observe at 30X), to 0.5 mm long; calyx tube 4–5 mm long, 4 mm wide at base expanding rapidly to 11 mm wide at throat; calyx teeth longer than the tube, upper teeth 5 mm long, 2 mm wide, lateral teeth 7 mm long, 1.7 mm wide, ventral tooth elongated, complicate, 13–15 mm long, 2.5 mm wide at the base. Vexillum broad, ca. 4.5–4.8 cm wide, complicate, densely sericeous-villosus on the outer surface, bearing a basal pouch ca 6 mm in diam. above the 4 mm long claw, and with a broad 1.8 mm sinus above the pouch and between it and a 3 mm long spur. Alae, carina, androecium, and gynoecium hidden within the complicate vexillum glued to the herbarium sheet, thus not observed. *Legume* unknown.

TYPE COLLECTION: NICARAGUA. Bois, environs de Grenade, 40 m, Janvier 1870, *Levy 419* (HOLOTYPE: P—plant "A" mounted on left side of sheet). Fig. 1.

The type specimen is mounted on a herbarium sheet along with another specimen labeled as "Herb. Mus. Paris, 1870, no. 20", which is mounted on the right side and labeled "B" by this author. It is to be excluded as part of the type specimen of *Centrosema seymourianum* as this specimen belongs to the genus *Phaseolus*. The type specimen includes only the specimen mounted on the left-hand side of the herbarium sheet, and which has been

Figure 1. Holotype of *Centrosema seymourianum* (*Levy 419*, P—plant "A" mounted on the left side of the herbarium sheet; excluding plant "B", *Levy* [?] *20*, mounted on the right side of the herbarium sheet.)

labeled "A".

A key is provided below to the species of *Centrosema* reported to occur in Central America.

1. Leaflets 1; petiole winged (Mexico to Colombia) ..... *C. sagittatum*
1. Leaflets 3; petiole not winged.
   2. Flowers small, 2–4 cm long; leaflets commonly small, 3–7.5 cm long; bracteoles 4–10 mm long.
      3. Upper calyx teeth much shorter than the tube; leaflets with main lateral nerves divergent at right angles from the midrib (Honduras to Brazil) ..... *C. angustifolium*
      3. Upper calyx teeth subequal to longer than the calyx tube; leaflets with main lateral nerves ascending from the midrib.
         4. Leaflets narrowly oblong or linear; legume short, weakly falcate (Costa Rica to Brazil) ..... *C. pascuorum*
         4. Leaflets ovate to oblong; legume long, straight.
            5. Calyx teeth very unequal, upper and lateral teeth short, ca 2–3 mm long and subequal to the length of the tube, lowermost tooth much longer than the tube length, 5–8 mm long; legume 10–20 cm long, 5–7 mm wide; leaflets ovate, pubescent on both surfaces at least in the juvenile state, veinlets somewhat inconspicuous (Mexico to Brazil, W. Indies) ..... *C. pubescens*
            5. Calyx teeth subequal, all much longer than the length of the tube, teeth ca 6–9 mm long; legume 6–12 cm long, 4–5 mm wide; leaflets ovate to oblong or linear-lanceolate, glabrate, veinlets conspicuously raised, prominent (Southeastern United States to Argentina, W. Indies, tropical Africa) ..... *C. virginianum*
   2. Flowers large, 4–6 cm long; leaflets commonly large, (5) 7–14 cm long; bracteoles 10–20 mm long.
      6. Leaflets broadly ovate to rhombic-ovate, often drying black; flowers 4–5 cm long; bracteoles exceeding calyx by two to three times calyx length, ca. 15–20 mm long; calyx tube 5–7 mm with obsolete to short teeth to 2 mm long; legume 9–10 mm wide (Mexico to Brazil, W. Indies, tropical Africa) ..... *C. plumieri*
      6. Leaflets oblong to elliptic-oblong or ovate-lanceolate, not drying black; flowers 5–6 cm long; bracteoles subequaling length of calyx tube and lowermost tooth, 10–13 mm long; calyx tube 4–5 mm long with conspicuous teeth subequal to longer than the tube length; legume 7–8 mm wide.
         7. Leaves ovate-lanceolate, subpilose below with trichomes spreading on the nerves; calyx sericeo-pilose, trichomes 0.5–1 mm long, conspicuous when viewed at 10X; vexillum gibbous (Mexico) ..... *C. galeottii*[2]
         7. Leaves elliptic-oblong, glabrate with very sparsely appressed trichomes on the nerves; calyx glabrate with scattered uncinate trichomes (to 0.4 mm long), sparse on the tube and more densely compacted on the calyx lobes, conspicuous when viewed at 30X; vexillum spurred (Nicaragua) ..... *C. seymourianum*

Acknowledgement is made to Helen Correll for the Latin description.

[2] CENTROSEMA **galeotii** Fantz, *nom. nov.* Basionym: *Clitoria grandiflora* Mart. & Gal., Bull. Acad. Brux. *10*: 189. 1843. Lectotype: *Galeotti 3284* (BR!). Non *Centrosema grandiflorum* Benth. of Brazil.

and to Daniel B. Ward, Dana Griffin III, and Donovan Correll for reviewing the manuscript and providing constructive criticisms.

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HALOGETON (CHENOPODIACEAE) IN NORTH AMERICA[1]

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The history, nomenclature, and geography of *Halogeton glomeratus* (Stephan ex Bieberstein) C. A. Meyer in Ledebour in North America have been investigated with attention given to both literature and herbarium specimens. Halogeton received intensive study in the United States between 1942 and 1961 because of its role in the mass mortality of sheep (oxalate poisoning) on western rangelands. Although it is apparently no less common today in the Intermountain Region, sheep mortality has been reduced through educational efforts, and interest in this plant has declined somewhat in recent years. Confusion has existed in the literature, but a herbarium study indicates only one species of halogeton present in the United States now or historically and its identity is confirmed as *Halogeton glomeratus*. Halogeton was introduced into the United States (probably from south-central Russia) earlier than previously reported (i.e. before 1930), live animals (Karakul) being the probable source of introduction. A number of the unnoticed halogeton infestations in the United States were likely initiated by migrating sheep. This species usually does not self-spread over long distances and should only gradually, at most, extend its present range. It will probably not become as widespread, nor represent as great a threat to western sheep flocks, as once was thought.

HISTORICAL PERSPECTIVE

Halogeton, an annual Eurasian chenopodiaceous genus, might well have remained an obscure weed but for the alarm it brought when large numbers of sheep were poisoned in the western United States. Although present in the United States at an earlier date, substantial awareness of halogeton did not come until 1942 when 160 head of sheep were fatally poisoned near Wells, Nevada (Erickson et al., 1952; Flemming et al., 1944). Stomach contents of these dead animals were composed almost entirely of this plant

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material. Subsequent feeding tests performed at the University of Nevada confirmed the strong circumstantial evidence of the poisonous nature of this plant (Flemming et al., 1944). The mass poisoning near Wells led to first attempts (in 1943) to control the weed, a mixture of furnace oil and detergent being employed (Erickson et al., 1952). This and subsequent control measures were largely unsuccessful.

Whereas halogeton was known (at least by a few people) to be present in the United States before 1942, it was not thought to be harmful (Kingsbury, 1964). In fact, it was even considered by some (Erickson et al., 1952) as fair forage for livestock. The casual regard in which halogeton poisoning was initially held in this country was doubtless due to the fact that there were apparently no reports of its toxicity in the Old World (Dayton, 1951), and thus no special reason to suspect it. However, suspicious small losses of livestock in the western United States had actually preceded the Wells incident (Kingsbury, 1964).

After the major poisoning at Wells, numerous minor losses of both sheep and cattle were soon reported in which halogeton was implicated (Erickson et al., 1952). However, a wider recognition of this taxon as a poisonous range plant was to wait until 1945 when 1620 head of sheep perished in a single day near Bridge, in south central Idaho (Morton et al., 1959a). Other severe losses in this Raft River area (Cassia County) included 750 head of sheep belonging to a Mr. John Ward of Almo, Idaho (ZoBell and Silcock, 1950). In fact, the problem became so serious in the mid 1940's that a dozen major sheep ranchers in the Raft River Valley were forced out of business (Stoddart et al., 1951b), finding it necessary in some cases to abandon their ranches. These and other events brought the noxious weed to the attention of the public by 1950, and generated an expansion of research by personnel of the U. S. Department of Agriculture. Popularized reports often took the form of alarming accounts of the spread of this "invader," sometimes with not so subtle innuendoes as to the country of native origin. The following are typical of the frightening titles or inflamatory headlines of the early 50's: "Sheep-Killing Weed," Life Magazine, Jan. 15, 1951; "Poison Rides the Range," Reader's Digest (condensed from the Denver Post), December 1953; "Another Russian Invades U.S.," the National Wool Grower, 1950; and "Soviet Weed Kills Sheep," Oakland Tribune, June 28, 1950. The Life Magazine article contained the statement that more than one-third of the flocks of sheep in the United States were in danger. It was understandably at this time that several agricultural colleges, universities, and range extension agencies in the western states took an active interest in halogeton, initiating various studies into its ecology and possible control. Professional interest was stimulated when the United States Congress appropriated over four-and-a-half million dollars for study in legislation (Halogeton Act, Velie, 1953). Co-operative projects and committees were established in Idaho (Erickson et al., 1952) and Utah (Stoddard et al.,

1951b) to investigate its biology and possible eradication. Warnings of the danger of halogeton appeared in agricultural extension service bulletins of several western states in the early 50's, including Arizona (Armer, 1952) where its occurrence has yet to be documented. Besides the usual admonitions of its effect on sheep, of possible habitats in which it might occur, that it is not controlled selectively by 2,4-D or similar herbicide sprays, and recommendations for trailing sheep so as to avoid it, these bulletins usually described the plant. Particular emphasis was given to means of distinguishing halogeton from the less dangerous Russian thistle (*Salsola kali* L.), another introduced chenopodiaceous plant with which it was sometimes confused. For example, Durrell (1951) stated: "[halogeton] resembles Russian Thistle, which is common throughout the country. However, it has a softer appearance, its leaves are sausage-shaped, succulent and fleshy. The bristle at the tip is softer than the spine on Russian Thistle leaves."

The toxicity and precise effects of halogeton on animals received additional attention during the late 1940's and early 1950's. Flemming et al. (1947), who had earlier (1943) reported halogeton as poisonous (containing oxalic acid), indicated the toxic substances to be "salts of oxalic acid which are elaborated and stored during the growth of the plant to maturity," present as two oxalate salts, water soluble and insoluble. Vawter (1950) subsequently described the mechanism, symptomology, and pathology of halogeton poisoning. Ingestion of only nine ounces will kill a large, mature sheep (weighing 135 to 165 pounds) within six to 10 hours due to "rapidly overwhelming loss of inorganic serum calcium." Vawter (1950, 1951) listed the symptoms as dullness, prostration and coma. Kidney sections examined under polarized light show large crystal aggregates of calcium oxalate in the tubules. Anderson and Huffman (1957) indicated these changes resulted in acute renal failure. According to Vawter (1950) there "seems to be no practical way of saving sheep after eating a lethal dose of the plant." The toxic form of oxalate was determined by Dye (1956) to be the soluble form, insoluble calcium oxalate being relatively harmless. Binns and James (1961) discussed the mechanism of sodium oxalate in the blood in precipitating calcium (with resultant alkalosis) and stated that the feeding of alfalfa pellets, supplemented with dicalcium phosphate, was helpful in preventing (not curing) poisoning in sheep.

More detailed study of the physiology of halogeton, particularly oxalate content and metabolism, was the concluding phase of an intensive two-decade study. Morton et al. (1959b) determined the oxalate content of plants to range from 18 to 21 percent of dry weight (about the usual range reported in the literature), declining somewhat during the growing season. Most of the oxalate was contained in the leaves, with relatively small amounts in the stems, and high oxalate concentration was associated with a high sodium content. Williams (1960) observed that soluble oxalate content of the plant, as well as growth and succulence, increased when sodium (as

NaCl) was added to nutrient solutions. In contrast to Morton et al., Williams found that the concentration of oxalate in the leaves continued to rise during the summer, attaining a peak in September. According to Williams, the leaves of vigorous plants often contain in excess of 30 percent soluble oxalate on a dry weight basis, with an additional three or four percent of the dry weight of the plant accounted for by insoluble oxalate. A dry-weight soluble oxalate content of 34.5 percent was reported by Cook and Gates (1960), a high percentage compared to most other oxalate-containing plants. Kingsbury (1965) indicated a 10 percent soluble oxalate content to be high for beet tops (considered potentially dangerous forage), well below the usual estimates for halogeton.

Both popular and scientific literature on halogeton decreased after 1961, although Kingsbury (1964) devoted attention to it in his comprehensive work on poisonous plants of the United States and Canada. Sheep losses from oxalate poisoning also declined, apparently from an awareness among sheep ranchers. Nonetheless, occasional reports of severe loss, particularly in Utah, continued to surface in various newspapers. As recently as 1971 (Associated Press, Salt Lake City, January 23), 1,180 head from a flock of 2,400 died near Garrison, Utah, close to the Nevada border. This report observed that "there's halogeton all over that area." Thus, a "slow down" in the literature probably did not reflect a decrease in populations, but rather indicated better education concerning the plant, a lessening of the earlier somewhat faddish interest in the weed, and the realization that halogeton would not actually kill one out of three sheep in the United States (as suggested by Life Magazine).

Questions left unanswered or inadequately answered include: When did halogeton enter the North American flora and by what means? What has been the pattern and the mechanism of its spread? Is it more common now than it was say 30 years ago? What is its probable future in the flora? Is more than one species of *Halogeton* present in the United States? And, perhaps surprisingly, what is actually the correct scientific name(s)? By taking a close look at the history of the literature on halogeton, and by examination of actual specimen records, this paper attempts to deal with these questions.

NOMENCLATURE

Since its appearance in the flora, three different names for halogeton in North America have found their way into the literature: *Halogeton sativus, H. souda,* and *H. glomeratus.* These three names are to be found among specimens in North American herbaria (although *H. glomeratus* is the common determination).

In 1936, the 77th Intermountain Forest and Range Experiment Station collection was forwarded to the Washington Office of the United States Forest Service (Dayton, 1951). These plants included two specimens (S-43 and S-44, collected in 1934 by Ben Stahmann, a Forest Service officer, one

mile northeast of Wells, Elko County, Nevada) which were the first records of halogeton for the U.S. These two specimens were not immediately identified. However, similar material (Field Museum, F 780344 and F 815074) collected by Mr. Stahmann from Wells in 1935 was subsequently determined by Dr. Paul Aellen, an authority on the Chenopodiaceae, as "*Halogeton sativus*" (based on *Salsola sativa* L., 1762), native to Spain and Algeria.

Standley (1937) first published on halogeton in North America, accepting Aellen's determination of Stahmann's 1935 material as *Halogeton sativus* (L.) C. A. Meyer. Standley, seemingly unaware of Stahmann's 1934 collection, commented that the genus was first collected in "1935" at Wells, and speculated that "it will be interesting to learn whether this new addition to the United States flora thrives as well as *Bassia hyssopifolia* (Pall.) Kuntze, a related plant of somewhat similar appearance, which, if I remember correctly, also was found in the United States first in Nevada." Standley further stated that "it [halogeton] is reported to be spreading rapidly." Confusion persisted in the literature as to whether the initial collection of halogeton was made in 1934 or 1935 (e.g. ZoBell and Silcock, 1950); however, herbarium records clearly show that 1934 is correct.

The question of the initial year of collection has not been the only confusion enshrouding halogeton in North America. Morton (1941) correctly observed that the publishing author of the combination *Halogeton sativus* was actually Moquin-Tandon (1840), rather than C. A. Meyer (as suggested by Standley and presumably also by Aellen). Although Meyer (1829) mentioned *Salsola sativa*, he never employed the combination *Halogeton sativus* (as did Moquin-Tandon). Therefore, the correct citation is *Halogeton sativus* (L.) Moquin-Tandon, not (L.) C. A. Meyer. However, Morton (1941) went on to discuss the existence of an earlier name for this species, viz. *Halogeton souda* (Loefling) Macbride (based on *Salsola souda* Loefling, 1758). Our examination of photographs of the type specimens of both *Salsola sativa* and *S. souda* in the Linnaean herbarium (LINN) confirms that they are probably the same species. Thus, if the adventive American taxon were considered to be the Spanish-Algerian species, *Halogeton souda* would be the correct name (on the basis of priority), with *H. sativus* relegated to synonymy. Fosberg (1940) used the name *H. souda* for halogeton in Nevada.

The question of *Halogeton sativus* vs. *H. souda* is relatively moot to our considerations, however, because Morton (1941) further indicated that North American specimens are not *Halogeton souda* (*H. sativus*) at all but belong instead to a Russian species, *Halogeton glomeratus*. It is apparent that Morton examined Old World specimens of both *H. souda* and *H. glomeratus*, although probably not the type specimen of either. Dayton (1951) subsequently offered a brief review of these taxonomic and nomenclatural problems, concurring with Morton. However, Dayton stated that the type of *H. glomeratus* was behind the "Iron Curtain," presumably in Moscow or Leningrad, and not available for examination. Thus, ultimate

certainty of the identity of North American specimens must have eluded both Morton and Dayton.

Through the auspices of Dr. V. I. Grubov, we obtained a loan of specimens from the Leningrad herbarium (LE), along with photographs (negatives) of the type specimen of *H. glomeratus*. Prints made from these negatives matched well with the specimens collected in the United States. Thus, North American specimens can now be classified with reasonable assurance as *H. glomeratus,* not *H. souda* (*H. sativus*).

Dayton (1951) and others indicated that the combination *Halogeton glomeratus* is traced to C. A. Meyer (1829) when he described the genus in Ledebour's *Flora Altaica.* Dayton, however, noted that C. F. Stephan (author of a Flora of Moscow) was actually the first to use the epithet (in connection with herbarium material) but that Stephan himself did not publish it. Stephan's specimen, however, is the type of *Halogeton glomeratus*, and is the specimen in the Leningrad herbarium. This specimen (lacking a date) is labeled "*Salsola glomerata*" in Stephan's handwriting. The name written by Stephan is a herbarium or "manuscript" name. However, Stephan's epithet "*glomerata*" was later validly published by Marshall von Bieberstein (a colleague of the well-known Russian botanist, Pallas) as *Anabasis glomeratus* (1806). Meyer (1829) subsequently transferred Bieberstein's *glomeratus* to *Halogeton.* The most complete and accurate author citation of the name (which we have understandably not seen published) would be *Halogeton glomeratus* (Stephan ex Bieberstein) C. A. Meyer in Ledebour.

Tutin (1964) considered *Halogeton glomeratus* and *H. sativus* (= *H. souda*) to be closely related species. In addition to the geographical separation, the Spanish species is to be distinguished by longer leaves, a more robust habit, longer perianth, and a greater number of stamens per flower. Our examination of specimens and phototypes lends support to those who separate these two species. However, if a future monographer were to combine *H. glomeratus* and *H. souda*, the name would then become *H. souda* on the basis of priority.

Halogeton, as is the case with many other chenopodiaceous genera, is in need of revision on a worldwide basis. This is evident from the variation in estimates as to the number of species of which the genus is composed: Ulbrich (1934) indicated that there are three species; Iljin (1936) called for four; and, somewhat inexplicably, Dayton (1951) suggested that there are 12. Regarless of whom one believes, there is agreement that more than one species exists. However, we consider that only one species (*H. glomeratus*) has been and is in the flora of the United States. We find no evidence to support Dayton's (1951) speculation that "it is perhaps only a question of time when one or more of these other species will emigrate to this country."

INTRODUCTION, SPREAD, AND DISTRIBUTION

Neither the manner nor the date of introduction of halogeton into the United States has been definitely established (Tisdale and Zappetini, 1953). Several references (Bellue, 1949; Standley, 1937; ZoBell and Silcock, 1950) indicated halogeton first entered the North American flora in 1935, although it was already common in the Wells area by 1934 (Dayton, 1951). It is apparent in the case of several "first records" for particular regions that infestations were extensive at the time of discovery (Bellue, 1949; Velie, 1953). Even the nature of various of the livestock losses reported, i.e. severe and sporadic, is an indication that it became abundant in certain areas prior to recognition. Stoddard et al. (1951b) set the time of entry back somewhat in suggesting the probable date of introduction from southern Russia "in about 1930." Binns and James (1961) likewise favored 1930 as a likely date of introduction.

Regardless of the exact time of introduction, it appears that halogeton became more common in western North America in the early 1930's. During this period an extremely dry climatic circumstance prevailed throughout most of the West. It is probable that the drought tolerant halogeton extended its populations (at least locally) while many native species suffered decline (Tisdale and Zappetini, 1953). This species does not compete well with healthy native perennial forbs (Fenley, 1952), yet it enters in force when soils are denuded (Erickson et al., 1952). As many as 50,000 winged seeds per plant (Morton et al., 1959a) are dispersed locally by the wind (Kingsbury, 1964). This and a wide ecological tolerance range permits halogeton to survive in habitats unfavorable to competitors (Erickson et al., 1952) and to "take over" local disturbed or barren areas quickly. The "Dust Bowl" of the western United States in the 1930's assuredly contributed to its spread.

Although undocumented, halogeton must have been present in North America before 1930 (Erickson et al., 1952). Erickson and his coworkers suggested three possible sources of introduction: 1) impurity in crop seed, 2) imported wool, or 3) importation with breeding stocks of sheep. Durrell (1951) and an anonymous writer in Life Magazine (1951) supported the introduction into this country as a contaminant in imported seed. Erickson et al. (1952) favored wool pelts or live animals as the vector, pointing out that new infestations coincide with sheep movements. Bellue (1949) simply commented that "Halogeton seed seems to have an affinity for and readily sticks to the wool of sheep," and that in Nevada, Utah, Idaho and Wyoming, the weed has "followed sheep trails and bedding grounds." Karakul sheep, among other possibilities, has been mentioned as a potential source of introduction and the most likely vector from the Soviet Union. In contrast to other breeds (including Angora), the natural range of the Karakul corresponds closely to that of halogeton. Karakul are native to desert-like areas of the Bokhara Province of southern Russia, and sheep with Karakul blood extend as far westward as the Caspian and Black Seas (Vaughan, 1931).

Halogeton glomoratus is well known from this general area (Iljin, 1936). Erickson et al. (1952) mentioned that both Karakul and Angora breeding stocks were imported into the United States between 1908 and 1925. Wentworth (1948) also alluded to the importation of Karakul early in the twentieth century. Vaughan (1931) identified "three lots" of Karakul that were imported (by Dr. C. C. Young), in 1908, 1912, and 1914 respectively. If Karakul were the vector, then 1908-1914 would be more likely the time of introduction than 1930 to 1934.

Circumstantial evidence for the ovine origin of halogeton infestation is found in the implicating comparison (Figure 1) between sizeable halogeton populations and major sheep trails of the early part of the century (these trails were in heavy use until about 1915). Several primary routes were used in sheep drives out of California (Wentworth, 1948), including southern (leaving Bakersfield), middle (leaving Fresno), and northern (leaving Red Bluff) passages. The southern and middle routes passed along the eastern flank of the Sierras, then across Nevada, proceeding through Wells (a major trail junction), and up into the Raft River Valley of southern Idaho. Tisdale and Zappetini (1953) pointed out that the Raft River Valley area was one of the principal winter ranges for sheep in the early 1900's. The northern route passed directly through the well-documented area of infestation in Lassen County, California, on the way to Wells and southern Idaho. Thus, the correlation between major sheep trails and a number of significant halogeton infestations is, in our opinion, not coincidental (Figure 1). Localities plotted are based on specimens examined from the following herbaria (Holmgren and Keuken, 1974): A, ARIZ, DAO, F, GH, ID, MU, NY, OSC, PENN, PH, RENO, RM, SMU, UC, US, USFS, UT, and WTU. Additional information on specimens was provided by: CAN, COLO, TEX, and UNM.

We consider, by virtue of the native home of the Karakul, its long fur (Persian lamb's wool) in which seeds might easily become entangled, the time of introduction of Karakul into the United States, and the apparent relationship between old sheep trails and the distribution of the plant, that halogeton was both introduced and subsequently dispersed by live sheep. Introductions by means of fur pelts or grain shipments are conceivable, but not as probable. Karakul skins were mailed in bundles of 500 each from Asia directly to New York City where they were processed (Vaughan, 1931), and therefore had no connection with halogeton growing in the western states. Grain shipments contaminated with halogeton seed could have accounted for a few populations of halogeton. Seed contamination has played a major role in the introduction of certain other chenopodiaceous weeds (Blackwell, 1978; Collins and Blackwell, 1979). But if the majority of infestations had actually been caused by contaminated grain, there should be no correlation between its occurrence and well-known sheep trails. Also, railroads for shipping grain were not established early in the 1900's through

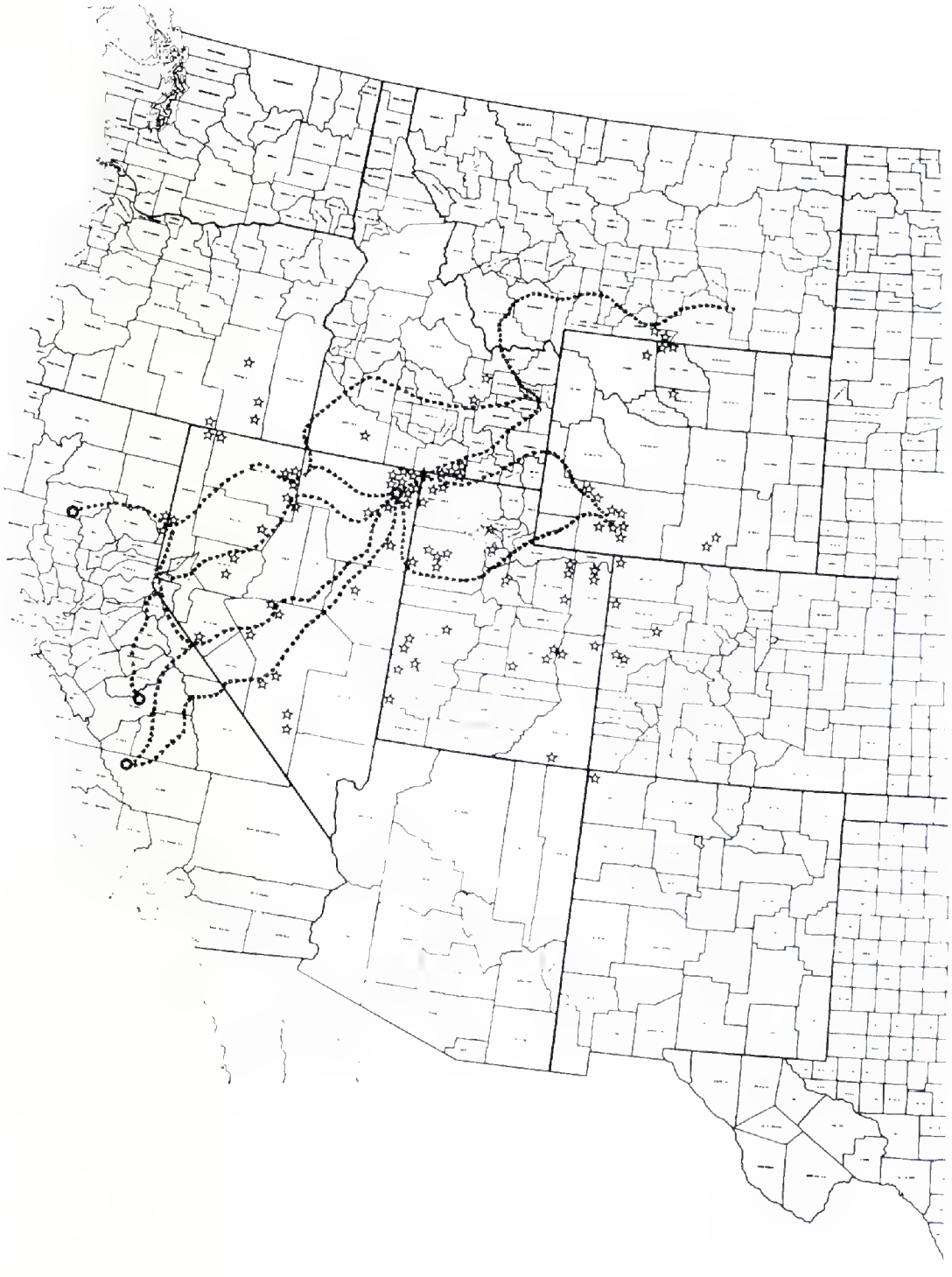

Figure 1. Distribution of *Halogeton glomeratus* in North America. Stars with thickened circular borders in California represent major sheep trail departure points (North to South, respectively, Red Bluff, Fresno, and Bakersfield). Star with thickened circular border in northeastern Nevada (Elko Co.) represents major sheep trail junction at Wells. Other stars (lacking thickened circular borders) represent locations of Halogeton populations based on herbarium specimen records. Sheep trails (double broken lines) are modified from E. N. Wentworth, 1948, *America's Sheep Trails.*

some of the areas of heaviest infestation. Thus, live animals, in particular the Karakul, would seem to have been the vector, and we believe halogeton to have been present and growing in the United States by 1915. It is somewhat ironic that the type of animal (sheep) which has been most adversely affected by its toxicity also appears to have been the source of introduction and dispersal.

The assumption (e.g. Stoddard et al., 1951b; ZoBell and Silcock, 1950) that halogeton was first introduced into Nevada, from there spreading to the other states (Utah, Idaho, Wyoming, etc.), may be invalid. Even though it spreads locally in great numbers, there is no evidence that it is dispersed across large distances without the aid of an external vector (such as sheep). Kingsbury (1964) indicated that wind is primarily effective only in local dispersal. Thus, a majority of present extensive areas of infestation probably correspond to the original sites of introduction by migrating sheep. While Wells, Nevada, was one of those early sites, it is *not* possible to be sure that it was *the* earliest. It is reasonable to say only that it was first collected there. It is conceivable, for example, that one or more of the Raft River Valley localities in Idaho might predate the Wells, Nevada, occurrence. There is no proof one way or the other. Since halogeton was present for a number of years, probably in a number of locations, prior to its discovery, it is not likely that the first site of occurrence in this country will ever be conclusively identified. But even if Wells were accepted as the initial locality (as it is in much of the literature), an autogenic spread of halogeton from there to other widely separated localities is less than plausible.

Bellue (1949) inferred that halogeton migrated from northwestern Nevada (located across the state from Wells) over the border into Lassen County, California. Yet, this rather isolated occurrence in northeastern California may have had nothing to do with its presence in Nevada. The California infestation could just as well have been initiated in situ in the early 1900's by a sheep drive. Bellue stated that "a survey made subsequent to our first California record in Lassen County in 1946, indicated that Halogeton had become scattered over several thousand acres." This extensive infestation did not develop overnight and it seems as feasible to us to speculate that halogeton had been there for some time (the introduction having taken place at or near the site) as to postulate a recent invasion from adjacent Nevada.

We believe that, whereas it is possible to determine a pathway of infestation (and a probable cause), it is not possible to establish meaningful chronology. Halogeton was, we think, independently and separately introduced by sheep into scattered localities, sooner or later becoming locally common in some of them; and since these introductions probably took place well before discovery of the plant, the order in which they transpired cannot be determined. If it were possible to establish the chronology of infestation, however, it is unlikely that it would follow an orderly geographic

sequence. Based on herbarium specimen records, and without any necessary implication of the sequence of spread, we can state that the first collections known in the following states were in the following order: Nevada, 1934; Utah, 1943; Wyoming, 1943; Idaho, 1946; Montana, 1951; California, 1951; Colorado, 1951; Oregon, 1954; and New Mexico, 1973. Halogeton was observed five years prior to collection in California (Bellue, 1949) and at least one year before collection in Idaho (Morton et al., 1959a). Thus, specimen records offer only a rough gauge of the time of awareness of its presence in the various states, and little or nothing about the actual time of its appearance in the state's flora.

Opinion has varied as to the prognosis for halogeton in North America. Holmgren (1950) stated that "it's migration into new areas is continuing at an alarming rate," and such a sentiment is echoed in popular articles in Life Magazine (anonymous, 1951) and Reader's Digest (Velie, 1953). More conservatively, Erickson (1952) stated that "the future distribution of halogeton cannot be forecast with accuracy at this time." Erickson did mention the possibility that it could eventually spread over the entire Intermountain Shrub Zone (Cold Desert region) and even into the western margins of the grasslands lying to the east. Perhaps it was simply too early, and with too little information at hand, to forecast accurately the future of halogeton in the United States, except to postulate that it would certainly persist (Stoddart et al., 1951a) and probably would not become any less common with time.

It appears that the present major areas of halogeton infestation are essentially those depicted in publications of the 1950's. Simple maps presented by Erickson et al. (1952) and the U. S. Department of Agriculture (anonymous, 1958), outline these areas rather well. To the USDA map, new localities can be added primarily in southern Oregon and northwestern New Mexico. According to herbarium records, no new "halogeton states," except for New Mexico, have been added to the list since 1954. Thus, it would seem that whereas halogeton can and does spread locally at a rapid rate, it does not readily establish new widely disjunct areas of infestation by its own devices. Bellue (1949), for example, noted that "the range of Halogeton is still confined to the original general location in the southeastern corner of Lassen County." And in the summer of 1977, two of us (Blackwell and Hopkins) carried out an extensive search throughout adjacent Modoc County, California, without turning up a single specimen. Suitable habitats were apparently abundant in Modoc County, yet halogeton had not spread there in more than 30 years of opportunity from either Lassen County or adjacent Nevada. Morton et al. (1959a) indicated that the total area of halogeton infestation was 10.5 million acres (though it is not clear how this figure was derived). It does not seem that the area of infestation today is much larger than this, although an accurate estimate is lacking. When compared with the USDA map of 1958, major areas of infestation do not

appear to have increased strikingly. This is not to imply that there have not been numerous instances of local increase, or numerous rather closely spaced small new infestations in various parts of the Intermountain Region. Undoubtedly, the fact that major sheep drives have drastically declined as a means of transporting sheep great distances is related to the present minor spreading of the plant. New areas of halogeton infestation now perhaps most commonly originate in disturbed habitats along roadways (personal observation, Blackwell, southern Oregon, 1977). Infestations in eastern Utah and western Colorado, New Mexico, and Oregon apparently developed in this manner. Thus, spread (not necessarily rapid) along roadsides allows movement into poorly managed rangeland.

Control of halogeton remains a concern. Of the various alleged methods, biological control has come to be among the more common suggestions. In particular, the use of crested wheatgrass (*Agropyron cristatum* Gaertn.) as a competitor was recommended (Fenley, 1952; Stoddart et al., 1951a). However, this, as various chemical control measures, produced dubious results (Morton et al., 1959a). Halogeton and crested wheatgrass were observed growing successfully together in Lake County, Oregon (Blackwell, personal observation, summer 1977). Perhaps Morton and his collaborators (1959a) summarized it best in stating that "the successful control of halogeton does not depend upon any single control method . . . Ultimate control of halogeton depends upon the restoration of vigor and productivity to good range forage plants."

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CHANGES IN *GALACTIA* (FABACEAE) OF THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Different names and realignments are presented for several species of *Galactia*. It is shown that *G. volubilis* (L.) Britt. and *G. macreei* M. A. Curtis sensu most recent authors should be called *G. regularis* (L.) BSP and *G. volubilis* (L.) Britt. respectively. *G. glabella* Michx. is supported as the replacement name for what has been treated by most authors as *G. regularis* (L.) BSP. *G. glabella* is shown to consist of three partly sympatric forms but studies are insufficient to decide what taxonomic status, if any, should be assigned to them. A diagnostic key for eight species and distribution maps for six species are presented. More detailed diagnoses than can be included in a key are presented for better understanding of *G. regularis, glabella, volubilis,* and *mollis*, specimens of which have been abundantly misidentified.

Galactia in the Southeastern United States has interested me for at least 30 years. Intermittently I have attempted to solve some of the many complex problems inherent in this genus, but only recently have sufficient data and conclusions been accumulated to justify their presentation. First I described one new species (Duncan, 1977). I am now presenting my remaining conclusions, fully aware that some may not hold up under future studies but also realizing the unlikelihood of my making further studies of this subject. Taxa confined to peninsular Florida are omitted due to insufficient study of materials from there. A key to all other species of the Southeastern United States as I interpret them follows.

KEY TO SPECIES

1. Leaves with 5–9 leaflets . . . . . *G. elliottii*
1. Leaves with 3 leaflets 2
   2. Plants erect, inflorescences subsessile . . . . . *G. erecta*
   2. Plants twining or trailing, inflorescences pedunculate 3
      3. Calyx lobes brown to reddish brown on inner surface when dry; corollas dark colored when dry, persisting after withering, sometimes partly present when fruit is mature . . . . . *G. mollis*
      3. Calyx lobes greenish-yellow to tan on inner surface when dry; corollas light colored when dry, falling as they wither or soon thereafter 4
         4. Stems with fine close mostly spreading hairs, the longest 0.7 mm or longer . . . . . *G. floridana*
         4. Stems with fine antrorse, retrorse, or spreading hairs under 0.7 mm long, rarely a few longer, but hairs not dense 5
            5. Hairs on stems antrorse 6
               6. Internodes only a little longer to usually shorter than the largest leaflet of adjacent nodes, hairs on stems 0.05–0.25 mm long . . *G. minor*

SIDA 8(2): 170–180. 1979.

6. Several to most internodes (especially those toward the base) much longer than the largest leaflet of adjacent nodes, hairs on the stem 0.1–0.8 mm long . . . . . *G. glabella*
5. Hairs on stems retrorse to spreading 7
7. Mature flowers 7–9 mm long . . . . . *G. regularis*
7. Mature flowers 10–18 mm long 8
8. Longest inflorescences 3–15 cm long, nodes near the tip close and the flowers congested; ovules 6–9 . . . . . *G. glabella*
8. Longest inflorescences 5–55 cm long, flowers in separated nodes and not congested near tip; ovules 10–13 . . . . . *G. volubilis*

DISCUSSION OF SPECIES

G. ELLIOTTI Nutt. and G. ERECTA (Walt.) Vail

These species have distinct features and are rarely confused with others in contrast with all other species, which are frequently misnamed.

G. MOLLIS Nutt.

This taxon is often confused with *G. floridana.* In addition to the characters in the key the legume of *G. mollis* has dense divergent hairs prominently visible macroscopically while in the former species the hairs are scarcely or not visible macroscopically and are retrorse-appressed to retrorse-spreading to a few scattered hairs being divergent.

G. FLORIDANA T. & G.

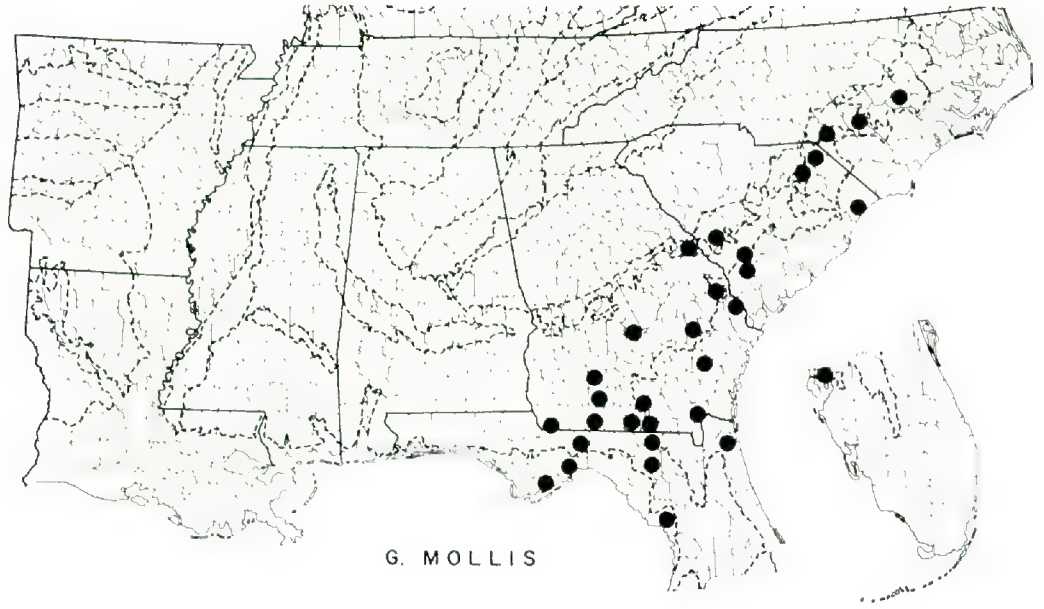
For the present this species is best treated as two varieties, *floridana* and *microphylla* Chapm. The latter has shorter internodes, smaller leaflets, shorter petioles, and the inflorescences are shorter than the leaves. Inflorescences are mostly longer than the leaves in var. *floridana.* Additional studies are needed to test this separation more thoroughly. Growing plants under the same conditions is likely to be helpful.

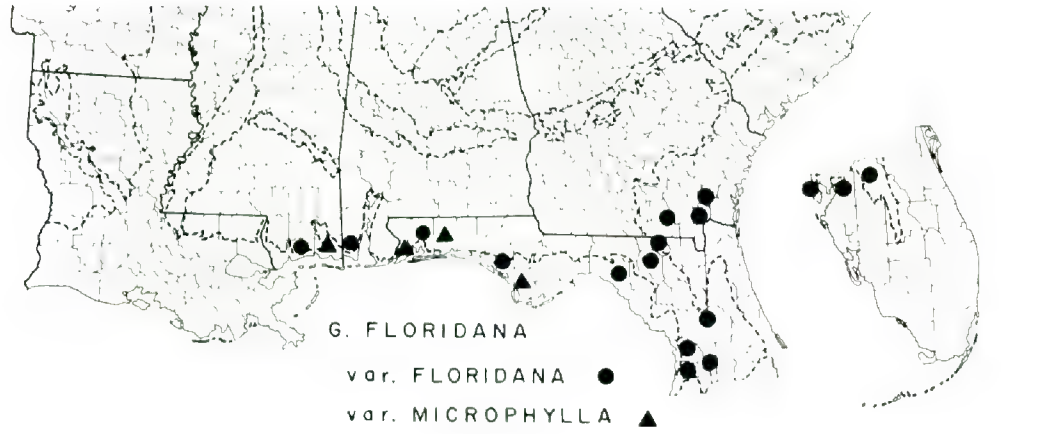
G. MINOR Duncan

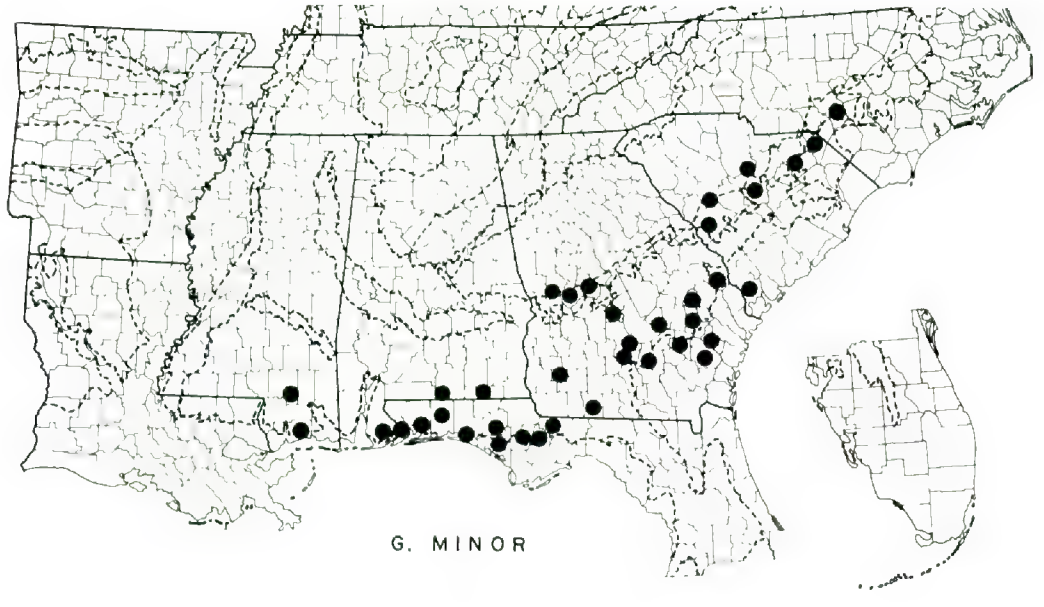
Additional aids to the identification of this taxon are: stems geniculate (uncommonly not), largest leaflets 14–28 mm long, inflorescences with 1–3(4) flowers, the longest inflorescence little if any longer to shorter than the subtending leaf, and flowers 11–17 mm long.

G. REGULARIS (L.) BSP.

For many years there seems to have been little disagreement among taxonomists concerning the application of the name *G. regularis.* Descriptions, although differing in some details, indicate that each author had the same taxon in mind. These authors include Small (1933), Fernald (1950), Gleason and Cronquist (1963), Wilbur (1963), and Radford et al. (1964). Under this name until now, as indicated by the descriptions, have been included individuals that were prostrate or rarely twining; had inflorescences shorter or longer than the leaves and with one to many flowers, nodes close in the upper part of most inflorescences, and flowers congested or few; flowers 10–18 mm long and with a calyx 6–10 mm long; and stem hairs 0.05–0.8 mm long and usually retrorse, but frequently antrorse and sometimes spreading [description mine].


G. MOLLIS


G. FLORIDANA
var. FLORIDANA
var. MICROPHYLLA


G. MINOR

Although at first glance the type specimen (Virginia — Clayton — ex. Herb. Gronovii in BM) in some respects looks like a specimen of *G. regularis* sensu recent authors, it differs significantly from the above description in several details. The calyx is only about 5 mm long, the flower only 8 mm long, the upper flower clusters are evenly spaced and not congested, and the hairs on the stem are soft and spreading which is very unusual for *G. regularis* as it has been interpreted. These data fit in all respects what has been treated variously as *G. volubilis* (L.) Britt. (Small, 1933, in part; Fernald, 1950; Wilbur, 1963; Gleason and Cronquist, 1963, in part; Radford et al., 1964), *G. volubilis* var. *mississippiensis* Vahl, and *G. mississippiensis* (Vahl) Rydb. Also the description by Linnaeus (Sp. Pl. II: 726. — no. 8, DOLICHOS *regularis*) can as easily be applied to this taxon as to what has been passing as *G. regularis*. Therefore, the name *G. regularis* should be used for *G. volubilis* sensu Fernald (1950) et al.

During the checking of hundreds of herbarium specimens, I noted that *G. regularis* and *G. mollis* often had been confused. The hairs on the stem do seem to intergrade in size and abundance, with *G. mollis* generally having the longer and more abundant hairs. A series of measurements of hairs on specimens of known identity probably will show that almost all specimens of these two species can be identified by hair characters. Until this is done, except for sterile specimens, there are other means of identification as follows:

Calyx greenish-yellow to tan on inner surface when dry; corolla light colored when dry, falling as it withers or soon afterwards; legume with scattered divergent to antrorse-appressed hairs scarcely or not visible macroscopically . . . *G. regularis*

Calyx brown to reddish brown on inner surface when dry; corolla dark colored when dry, persisting after withering, sometimes partly present when fruit is mature; legume with dense divergent hairs prominently visible macroscopically . . . *G. mollis*

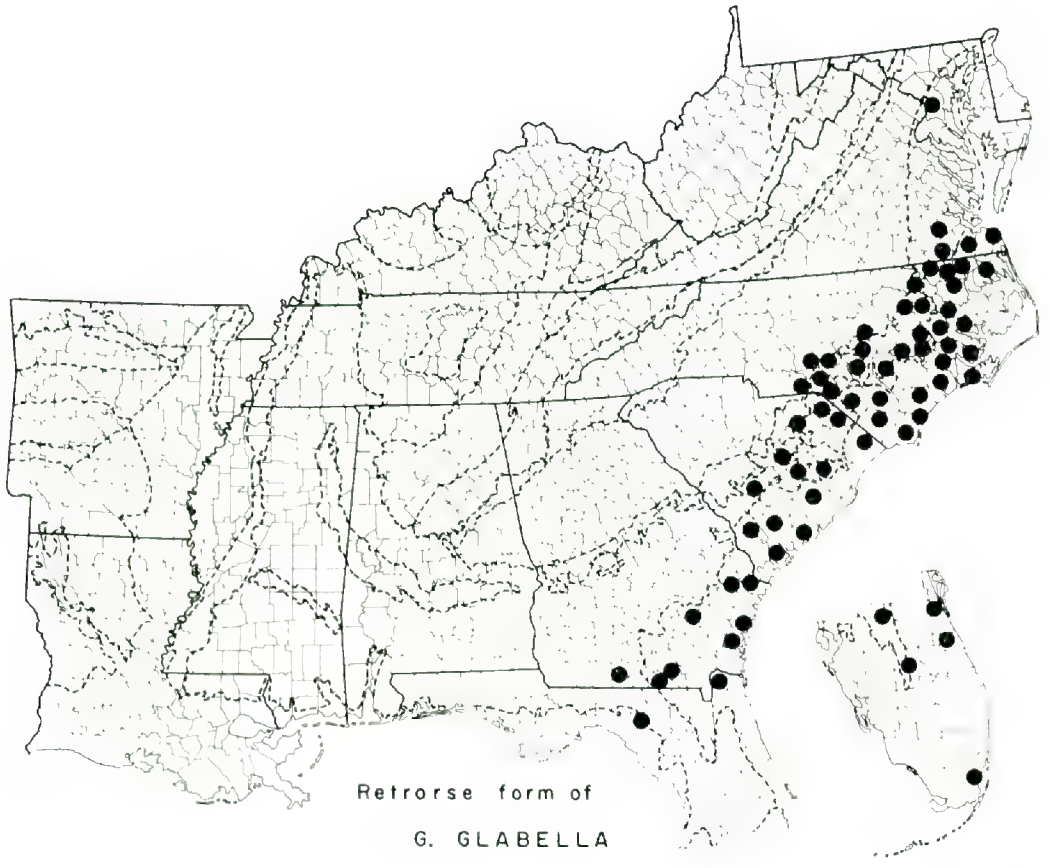
A partial synonomy of *G. regularis* should be useful in adjusting to the new application of this name and follows:

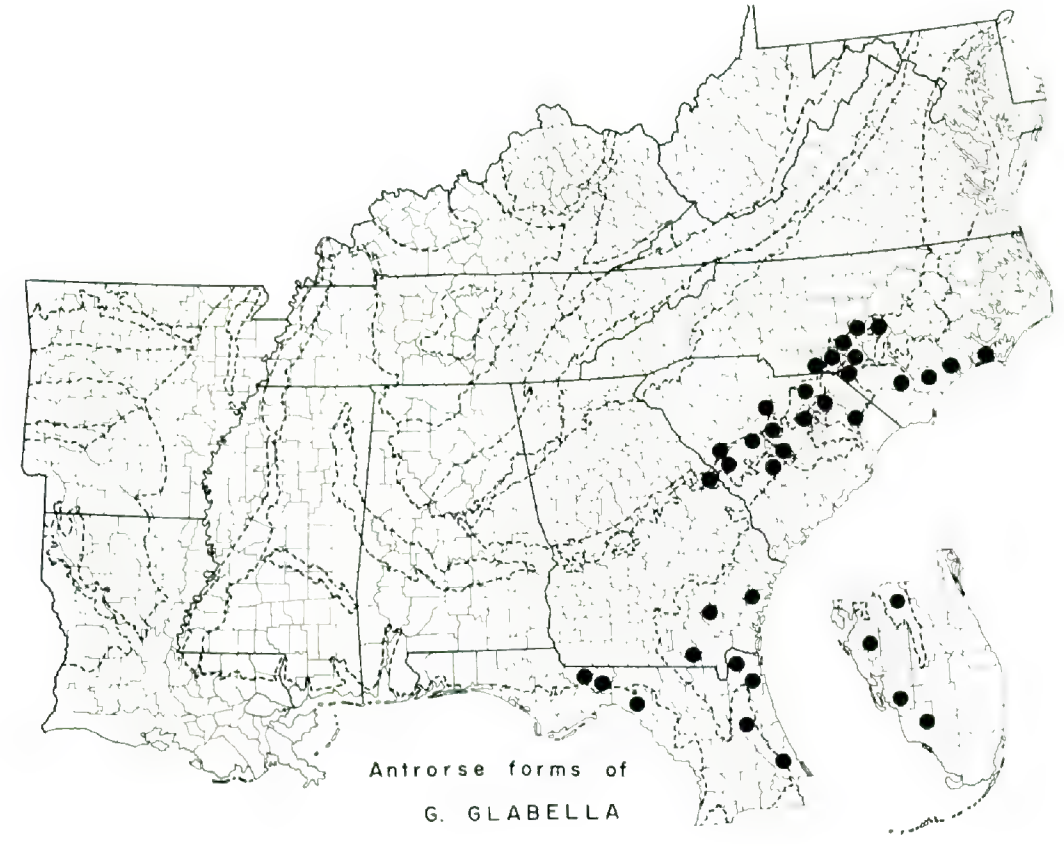
Galactia regularis (L.) BSP. Prel. Cat. N.Y. 14. 1888.

Dolichos regularis L. Sp. Pl. 726. 1753.
?Hedysarum volubile L. Sp. Pl. 750. 1753.
?Ervum volubile Walt. Flr. Car. 187. 1788.
Galactia mollis Nutt. Gen. 2: 117. 1818. Not Michx., 1803.
Galactia pilosa Ell. Bot. S.C. and Ga. 2: 238. 1824. Not Nuttall, 1818.
Galactia villosa Eaton & Wright. N. Am. Bot. 248. 1840. Not Wight and Arnott, Prodromus Fl. Ind. Orient I. 1834.
Galactia volubilis (L.) Britt. Mem. Torr. Club 5: 208. 1894. Sensu:—Small, 1933, in part; Gleason & Cronquist, 1963, in part; Fernald, 1950; Wilbur, 1963; Radford et al., 1964.
Galactia volubilis (L.) Britt. var. *mississippiensis* Vail. Bull. Torr. Bot. Club 22: 500. 1895.
Galactia mississippiensis Vail. Bull. Torr. Bot. Club 22: 500. 1895.

G. GLABELLA Michx.

In order best to understand the application of this name it is useful to


Retrorse form of
G. GLABELLA


Antrorse forms of
G. GLABELLA

discuss the variability of the plants that have long been designated as *G. regularis*. Actually there are two and maybe four taxa involved. One is *G. minor* which has been discussed. The remaining plants of the former *G. regularis* consist of at least three types of plants. One has retrorse or very rarely retrorse-spreading hairs. The other two types have appressed antrorse or very rarely partly antrorse-spreading hairs. No plants have predominately divergent hairs. The three types have definite distributional patterns which coincide only partly. They have some characteristics in common which are different from those of *G. minor*, including having the stems straight, not geniculate; several to most internodes much longer than the longest leaflet of the adjacent nodes; the longest inflorescences longer than the subtending leaves, uncommonly shorter, and with several to many flowers, rarely as few as 4, the upper nodes close and the flowers congested in the larger inflorescences. It is interesting that Small (1933) reserved the name *G. regularis* for those individuals having "minutely retrorse-pubescent" stems. However, none of the other species he includes can be the antrorse-haired *G. minor*.

The "retrorse" population is much more abundant than the "antrorse" ones. Its characteristics essentially are those recognized in publications for those plants until now designated as *G. regularis*. The next oldest name that possibly could apply to this "retrorse" taxon is apparently ERVUM? *volubule* (Walter Flr. Car. 187. 1788). However, Linneaus (Sp. Pl. II: 750. 1753) had used the epithet previously describing the plants as having "caule volubile," which is unusual for this taxon. Furthermore, I shall show later that *voluble* applies to another taxon.

I believe, however, that Michaux's *Galactia glabella* (Fl. Bor. Am. 2: 62. 1803) can be used for the "retrorse" taxon with reasonable confidence. Michaux's description of the plants as being (translation) "almost glabrous: leaflets oblong-oval, both ends shallowly notched, obtuse: calyx glabrous" is unlikely to apply to any other *Galactia*, and especially to those taxa known to occur where the type specimen was collected, namely *G. volubilis* and the "retrorse" plants. At flowering the calyx of *G. volubilis* is nearly always appressed hairy and only rarely nearly glabrous. On the other hand, the calyx of specimens of the "retrorse" plants is often glabrous or nearly so.

The type specimen of *G. glabella* (Michx. Herb.—Col. Co.—S. Carolina —in P) neither supports nor rejects application of the epithet to either of the above taxa. The specimen is apparently from Colleton County, which included at that time all of Charleston County southwest of the Ashley River. The specimen consists of three separate partly twining pieces, all sterile. None of its characters strongly favors either taxon other than the twining which is much more common in *G. volubilis*. However, rather than creating a new name because of this possible discrepancy, I favor using *G. glabella* on the basis of the strong implications involved in Michaux's describing the calyx as glabrous. His description most likely is based on a specimen from the "retrorse" population.

A detailed description of *G. glabella* (*G. regularis*, in the sense of previous authors, minus *G. minor* and the other "antrorse" populations) should be helpful and follows:

Perennial herb. Stems prostrate, straight or sometimes twining, bearing appressed to rarely spreading—retrorse hairs 0.02–0.45 mm, or rarely a few scattered hairs to 0.7 mm long; some internodes, if not all, longer than the longest leaflet of the subtending nodes. Leaves compound, 28–92 mm long; leaflets 3, elliptic to narrowly elliptic to narrowly ovate to ovate, usually retuse, entire, largest per plant 7–20 mm wide and 20–45 mm long, thinly antrorse-appressed hairy beneath, glabrous or sometimes antrorsely scabrous above. Inflorescences axillary, longest 2–15 cm long, longer than the leaves, rarely shorter. Longest pedicels at flowering 2–5 mm long. Flowers 5–13 per inflorescence, 12–18 mm long. Calyx 5.5–9 mm long, glabrous or with antrorse appressed hairs. Longest dehiscing anthers usually 0.88–1.20 mm long (1:17 is less than 0.88 mm long). Legume 35–52 mm long and 4.5–5.7 mm wide, bearing appressed antrorse hairs. Maximum number of ovules or seeds (including aborted ones) per specimen 6–9(10) per legume.

Representative specimens include: VIRGINIA: Southampton Co.: *Fernald and Long 8744* (DUKE); NORTH CAROLINA: Pender Co.: *Wilbur 4136* (FSU, GA); Scotland Co.: *Fox and Godfrey 2412* (DUKE). SOUTH CAROLINA: Orangeburg Co.: *Ahles 31751* (NCU). GEORGIA: Chatham Co.: *Duncan 21128* (NCU), *Duncan 21229* (GA). FLORIDA: Brevard Co.: *Kral 5066* (FSU).

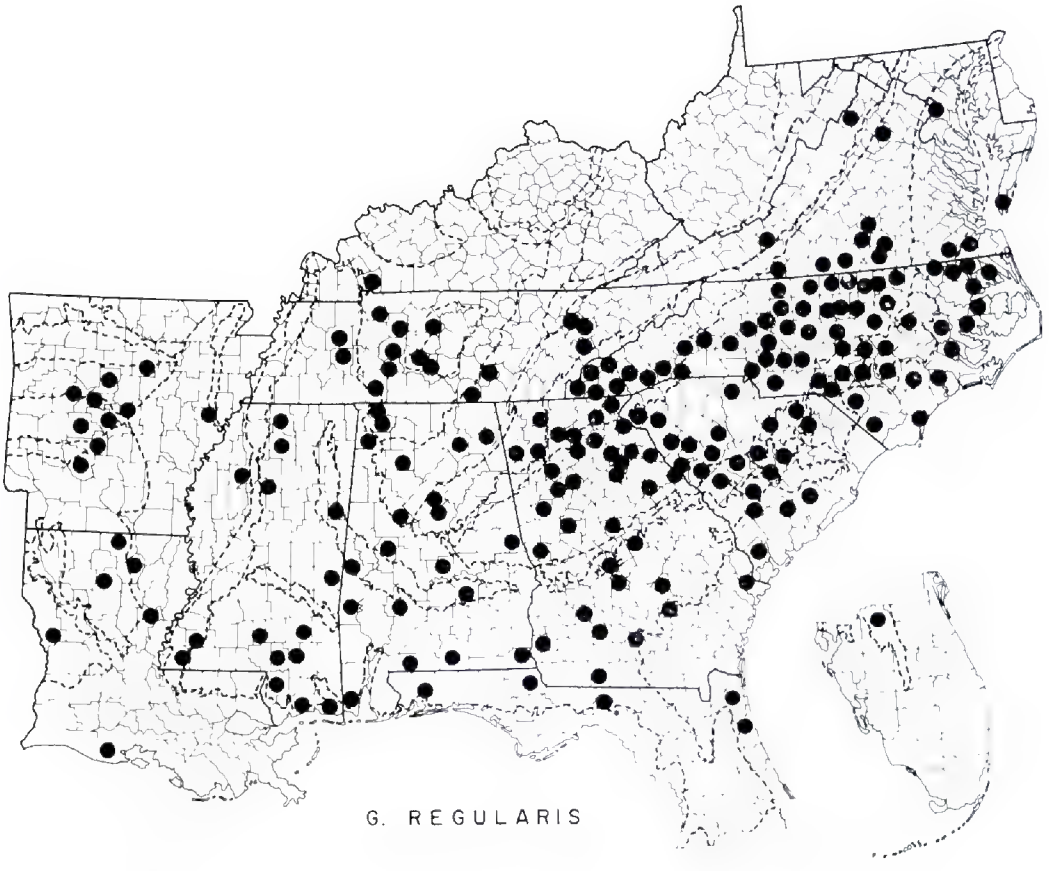
I have no strong feelings as to how the "antrorse" population should be treated, as a separate species, as a variety of *G. minor* or *G. glabella*, or otherwise. It seems useful to others to point out that the Florida material and that from the coastal and adjacent counties into North Carolina have leaflets averaging broader than those of the more inland populations of NC, SC, and GA. The narrow aspect of the leaflets of this latter group is quite evident in comparison, width-length ratios being mostly around 1:3(4) as compared to mostly 1:2. I have other commitments which will keep me from attacking these and other problems involved for at least several years and so am leaving them for others who I know are interested in the problem. Until further studies can be made, it seems best to include these as forms of *G. glabella*, providing them with no names.

Representative specimens of the antrorse forms include: NORTH CAROLINA: Bladen Co.: *Rogers and Blomquist 3120* (DUKE). Moore Co.: *Fox and Godfrey 2424* (GA). Richmond Co.: *Correll 1079* (DUKE). Scotland Co.: *Ahles 28568* (NCU). SOUTH CAROLINA: Lee Co.: *Radford 27337* (NCU). Kershaw Co.: *Radford 23549* (NCU). Marion Co.: *Bell 13677* (NCU). GEORGIA: Clinch Co.: *Norris 1132* (USC). Charlton Co.: *Duncan 22068* (GA). McIntosh Co.: *Bozeman 2824* (NCU). FLORIDA: Lee Co.: *Moldenke 951* (DUKE). Nassau Co.: *Godfrey 64135a* (FSU), *Godfrey and Lindsey 56855* (FSU).

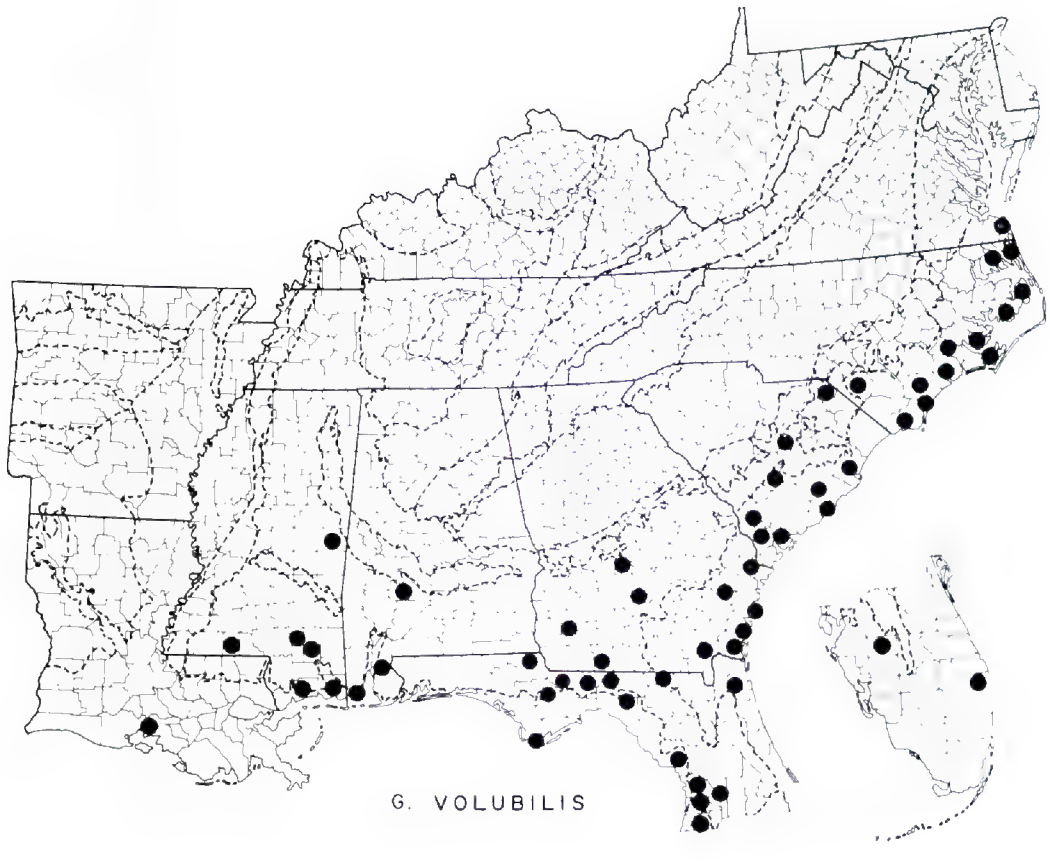
Useful synonomy for *G. glabella*:

Galactia glabella Michaux. Fl. Bor. Am. 2: 62. 1803.

Galactia pursbii Desv. Am. Sci. Nat. 9: 413. 1826.



G. REGULARIS



G. VOLUBILIS

Galactia regularis (L.) Britt. Sensu Small, 1933. In part sensu: Fernald, 1950; Gleason & Cronquist, 1963; Wilbur, 1963; Radford et al., 1964.

G. VOLUBILIS (L.) Britt.

As indicated earlier, *G. regularis* has been treated by recent authors as *G. volubilis*. These decisions were apparently based largely on the description by Linnaeus and an illustration he cited (Dill. Elth. 173. t. 143. f. 170). The description could just as well cover *G. macreei* M. A. Curtis sensu Fernald (1950), Wilbur (1963), and Radford et al. (1964). It is also quite doubtful which of these species the illustration represents. The leaf shape and relatively long pedicels are probably of the latter. The retrorse-spreading hairs on the stem and the antrorse-spreading hairs on the calyx are likely of *G. regularis*. However, I have seen each of these characters on specimens[1] of *G. macreei* sensu above. Although the apex of the standard of the latter is rounded or nearly so and that of *G. regularis* is retuse, the illustrations (Dill. Elth., above) of the flower are inconclusive as characteristics of both taxa are displayed. On these bases application of the epithet *volubilis* is clearly in doubt. Fortunately help is provided by a specimen in the Dillenius Herbarium labeled "Hedysarum trifoliatum scandens." From 1:1 photocopies of the specimen and other data provided by F. White, Curator of the Herbaria at Oxford University, Great Britain, the following diagnostic characteristics were derived: Hairs on stems retrorse-appressed, longest inflorescence 29 cm long with well separated nodes, longest pedicels at flowering ca. 4 mm long, longest flower 13 mm long, longest calyx ca. 6 mm long, the corolla light colored when dry. The specimen is clearly of *G. macreei* sensu the authors indicated earlier. On the basis of priority, however, *G. volubilis* (L.) Britt. should be used for the taxon.

G. volubilis and *G. glabella* are similar in several ways and have been confused. Both twine, the former occasionally and the latter usually, but when the latter is growing in bare areas it cannot climb and is prostrate like the former. They may be separated as follows:

Longest inflorescences 3–15 cm long, upper flower clusters congested; longest flowers 12–18 mm long; longest dehiscing anthers usually 0.88–1.20 mm long (1:17 is less than 0.88 mm long); maximum number of ovules or seeds (including aborted ones) per specimen 6–9, rarely 10(1:26) per legume. . . . . *G. glabella*

Longest inflorescences 5–55 cm long, all floriferous nodes well separated; longest flowers 10–14 mm long ; longest dehiscing anthers 0.65–0.88 mm long; maximum number of ovules or seeds (including aborted ones) per specimen usually 10–13, rarely 9(1:43) per legume. . . . . *G. volubilis*

Numerous plants of *G. volubilis* have also been identified as *G. regularis* sensu Duncan and also the reverse. This can be prevented by checking the following differences:

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[1] Jasper Co., SC; H. E. Ahles 15677; NCU 103886 + 103876.—Long Co., Ga.; J. R. Bozeman 2114; GA 94661.

Hairs on the stems usually spreading, to occasionally retrorse-spreading to uncommonly retrorse appressed; leaflets mostly elliptic to ovate; longest inflorescences usually 3–15 cm long, longest pedicels at flowering 2.0–2.5 mm long; longest calyx 4.0–5.5 mm long; longest flowers 7–9 mm long; longest dehiscing anthers 0.38–0.63 mm long; hairs on legume spreading to uncommonly antrorse (rarely appressed); maximum number of ovules or seeds (including aborted ones) per specimen usually 5–7, occasionally 4 or 8, or rarely 3 or 9[2] (1:133) per legume. . . *G. regularis*

Hairs on the stems usually retrorse appressed to uncommonly retrorse-spreading; leaflets narrowly elliptic to narrowly ovate or approaching the above; longest inflorescences 5–45 cm long, longest pedicels at flowering 3.0–4.0 mm long; longest calyx (5.5) 6–10 mm long; longest flowers 10–14 mm long; longest dehiscing anthers 0.65–0.88 mm long; hairs on legume antrorse-appressed or rarely antrorse-spreading; maximum number of ovules or seeds (including aborted ones) per specimen usually 10–12, occasionally 13, or rarely 9[3] (1:43) per legume . *G. volubilis*

Partial synonomy for *G. volubilis* follows:

Galactia volubilis (L.) Britt., Mem. Torr. Club 5: 208. 1894. Sensu: Small (1933) in part, Gleason & Cronquist (1963) in part.

?*Hedysarum volubile* L. Sp. Pl. 750. 1753.

?*Ervum volubile* Walt. Flr. Car. 187. 1788.

Galactia pilosa Nutt. var. *macreei* (Curtis) T. & G. Fl. N. Am. 1: 287. 1838.

Galactia pilosa Nutt. var. *angustifolia* T. & G. Fl. N. Am. 1: 287. 1838.

Galactia macreei M. A. Curtis, Bost. Jour. Nat. Hist. 1: 120. 1837. Sensu Fernald (1950), Wilbur (1963), Radford et al. (1964).

Galactia volubilis (L.) Britt. var. *intermedia* Vail, Bull. Torr. Bot. Club 22: 508. 1895.

DISTRIBUTION

During this study distribution maps were prepared for *Galactia minor*, the retrorse form of *glabella*, the antrorse forms of *glabella, regularis, volubilis, mollis*, and *floridana*. The specimens were mostly from DUKE, FSU, GA, NCU, VDB, and VSC. A few were from FLAS, GH, NY, and US. These distribution data were essential during my study, and are useful in understanding my interpretations of these taxa. They are presented here for the Southeastern United States.

Appreciation is expressed to my colleague, Dr. Samuel B. Jones, for suggestions involving the study; to Dr. G. Taylor, Keeper of Botany, of the British Museum, London, who many years ago provided details about the type specimen of *Galactia regularis*; and to F. White, Curator of the Herbaria at Oxford University, Great Britain. The loan from Duke University Library of the Ph.D. dissertation, "The genus *Galactia* in the United States," by Hollis J. Rogers and the loans of specimens through the courtesy of curators of the several herbaria are appreciated.

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[2] The only specimen with 9 seeds is from Yell Co., Ark.

[3] The only specimen with 9 seeds is from Iberia Parrish, La.

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SMALL, J. K. 1933. Manual of the southeastern Flora. Univ. of North Carolina Press. Chapel Hill. 1554 p.

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A NEW SPECIES OF *LINUM* FROM SOUTHERN TEXAS AND ADJACENT MEXICO

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In an earlier publication (Rogers, 1968) one of the yellow-flowered flaxes, *Linum rigidum* Pursh, was described as comprised of four varieties. Of these the typical variety and var. *compactum* are plants of northern Texas and northward. The var. *berlandieri*, with some reason sometimes considered a separate species, is distributed nearly throughout Texas. It is rather readily distinguished from the other varieties by its comparatively thick-walled fruit and coarse sepals. These three varieties, although displaying some variation which may require further study, are reasonably well defined. The fourth variety, var. *filifolium* Shinners, however, was described as a "variable population . . . more study is necessary to determine the relationship of the western Texas plants to those of southern Texas, as well as some anomalous collections included here from northern Mexico." In order to help clarify these relationships, the author has collected additional material of var. *filifolium* and attempted a number of crosses between plants from different parts of its range. Herbarium material from the New York Botanical Garden, Southern Methodist University and the University of Texas, including the Lundell Herbarium, has also been reexamined and thanks are expressed to the respective curators.

Within this "variable population," in addition to *Linum rigidum* var. *filifolium*, which, as now interpreted, is a plant of western Texas and nearby Coahuila, two taxa, mostly of southern Texas and adjacent Tamaulipas and Nuevo Leon, can be distinguished. These are *L. elongatum* (Small) Winkler, a species proposed many years ago (Small, 1907), and previously regarded as a synonym (Rogers, 1968), and *L. lundellii*, a previously undescribed species. The latter is named for C. L. Lundell, long a student of the Texas flora and co-collector of the type specimen.

The three taxa may be distinguished from one another in the following way:

1. Styles 7–8 mm long; petals mostly ca. 15 mm long.
   2. Sepals lanceolate, acute; petals diffusely brick-red at the base; annual . . . *L. rigidum* var. *filifolium*
   2. Sepals lance-attenuate; petals with reddish to wine-colored band below the middle; mostly perennial . . . *L. elongatum*.
1. Styles 3–4 mm long; petals ca. 10 mm long . . . . *L. lundellii*

In the following descriptions, petal and anther coloration is taken from

SIDA 8(2): 181–187. 1979.

a limited number of living plants, supplemented by scattered information from herbarium labels.

LINUM RIGIDUM Pursh var. FILIFOLIUM Shinners *in* McVaugh, Field & Lab. 17: 136. 1949. Type: *McVaugh 7798*, 4 Apr 1947, near abandoned wax factory on Rio Grande at mouth of Big Canyon, Brewster Co., Tex. (Holotype: SMU; isotype: TEX).

More or less stiffly branched, essentially glabrous annual herb, 15–35 cm tall; leaves alternate, linear, 10–30 mm long, 0.5–2.0 mm wide; stipular glands mostly present (80% of the specimens examined have stipular glands, but see the discussion which follows the species descriptions); sepals lanceolate, sharply acute, 6–9 mm long, grayish; petals narrowly to broadly obovate, 13–17 mm long, yellow to orange or salmon, brick-red near the base, not banded (Fig. 4a); stamens 5–6 mm long; anthers 1.5–2.5 mm long, yellowish; styles 6.5–8.0 mm long; stigmas dark-wine to black; fruit ovate, ca. 3.5–4.0 mm high, 3.0 mm diameter; seeds reddish-brown, ca. 3.0 mm long, 1.25 mm wide; chromosome no. $n = 15$ (chromosome voucher: *Rogers 13494*, 29 Aug 1976, 4 mi SE of Del Rio, Val Verde Co., Tex. WUD). About 70 collections have been examined. The following citations include the Mexican collections and a specimen from each of the counties in Texas.

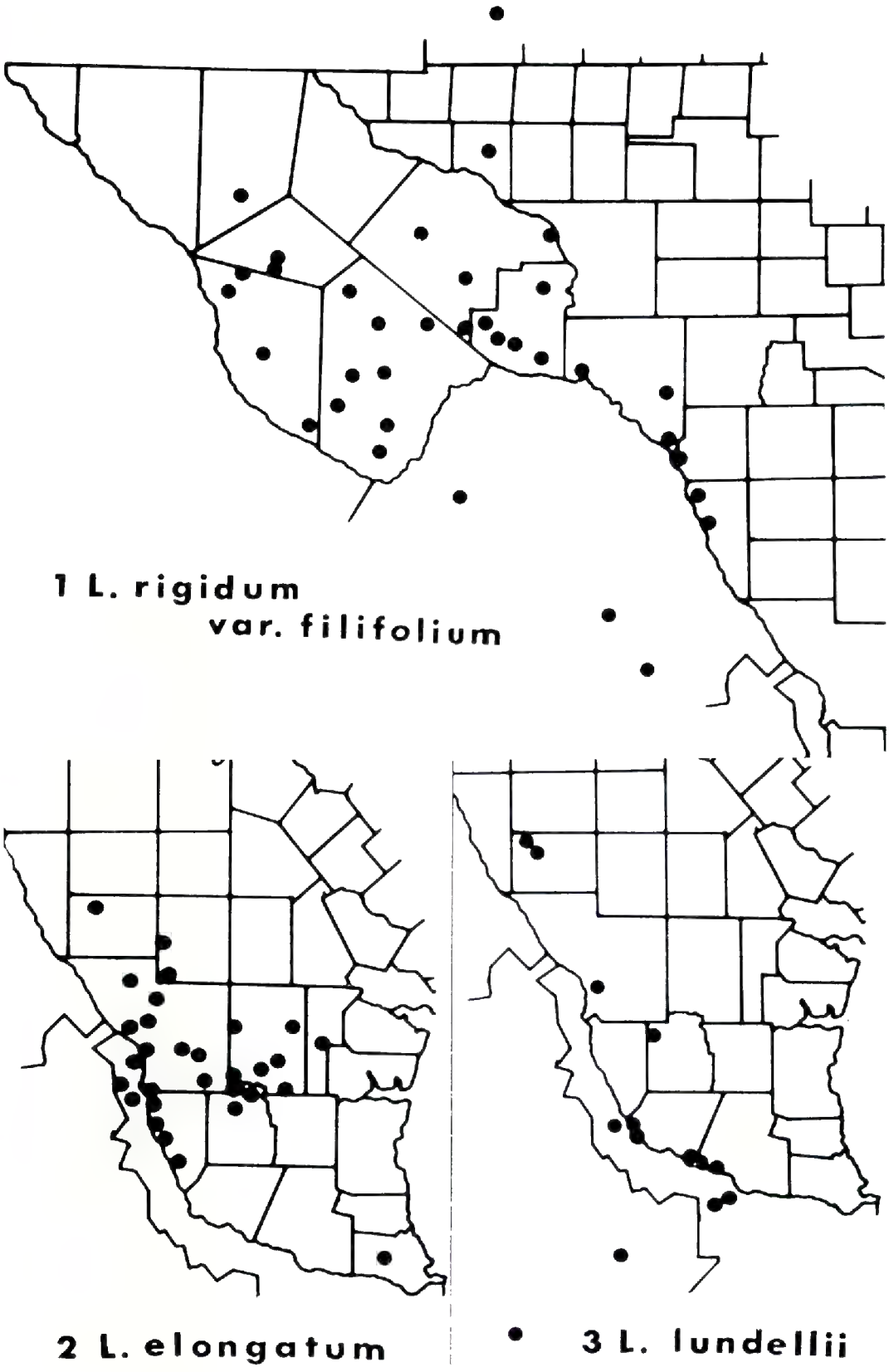
MEXICO. Coahuila: ca. 100 mi NW of Muzquiz, 12 May 1968, *Latorre s.n.* (TEX); Santa Rosa Mts., 14 Jul 1938, *Marsh 1386* (TEX); S of Sabinas, 29 Mar 1959, *Rinehart 289* (WUD).

U.S.A. Texas. Andrews Co.: 23 mi on Eunice Highway, 8 May 1960, *Scuddy s.n.* (nearest *L. australe* but apparently with some features of var. *filifolium*) (LL). Brewster Co.: 26 mi E of Marathon, 23 Aug 1947, *Warnock 6719* (TEX). Crane Co.: ca. 10 mi NW of Crane, 9 May 1966, *Correll 32773* (appears to combine traits of var. *filifolium* and var. *rigidum*) (LL). Culberson Co.: 51 mi W. Balmorrhea, 29 May 1967, *Mears 1565a* (TEX). Jeff Davis Co.: SW of Mt. Livermore, Davis Mts., 15 Jun 1926, *Demaree & Palmer 212* (SMU). Kinney Co.: 17 mi SE of Del Rio, 29 Aug 1976, *Rogers 13493* (WUD). Maverick Co.: 6 mi N of Quemado, 4 Apr 1959, *Correll 20727* (LL). Pecos Co.: 10 mi S of Ft. Stockton, 10 Apr 1948, *Warnock 7691* (LL). Presidio Co.: ca. 11 mi W of Valentine, 25 Jun 1948, *York 48185* (TEX). Terrell Co.: 3 mi W of Dryden, 30 Aug 1976, *Rogers 13498* (WUD). Val Verde Co.: near Del Rio, 30 Mar 1963, *Correll 27114* (LL). The distribution is shown in Fig. 1.

LINUM ELONGATUM (Small) Winkler, Nat. Pflanzenfam, ed. 2, 19a: 116. 1931. Type: *Reverchon 3776*, 21 Mar 1903, Laredo (Webb Co.), Tex. (Holotype: NY).

Cathartolinum elongatum Small, North Amer. Flora 25: 82. 1907.

More or less diffusely branched, annual (or merely flowering first year?) or perennial, essentially glabrous herb, 15–30 cm tall; leaves alternate, linear, 5–25 mm long, 0.5–1.0 mm wide; stipular glands present throughout or at bases of upper leaves only; sepals mostly lance-attenuate, 6–11 mm long; petals broadly obovate, 14–18 mm long, yellow-orange to salmon or brown-



Figs. 1-3. Distributions of *L. rigidum* var. *filifolium*, *L. elongatum*, and *L. lundellii*.

ish-red, with a prominent wine-colored band below the middle (Fig. 4b); stamens 5–6 mm long; anthers 1.5–2.5 mm long, brick-red; styles 7.0–9.5 mm long; stigmas mostly grayish to wine-colored; fruit ovate, ca. 4 mm high, 3 mm in diameter; seeds reddish-brown, ca 3 mm long, 1.2–1.3 mm wide; chromosome no. $n = 15$ (chromosome vouchers: *Rogers 13475*, 27 Aug 1976, farm road 2895, 5 mi N of jct. with Tex. 359, Webb Co., Tex.; *Rogers 13482½*, 28 Aug 1976, 1 mi SE of San Ygnacio, Zapata Co., Tex., both WUD). About 65 collections have been examined. The following citations include the Mexican collections and a specimen from each of the counties in Texas.

MEXICO. Tamaulipas: 7 mi S of Nuevo Laredo, 12 Apr 1964, *Fields 45* (TEX); 16 mi S of Nuevo Laredo, 7 Mar 1962, *Garza 35* (TEX); 14 mi S of Nuevo Laredo, 24 Mar 1944, *Heard & Barkley 14604* (TEX); 10 mi SE of Nuevo Laredo, 8 Mar 1964, *Ibarra 103* (TEX); 12 mi S of Nuevo Laredo, 26 Jun 1963, *Rogers 12845* (WUD); 2 mi S of Nuevo Laredo, 26 Jun 1963, *Rogers 12846* (WUD); 7 mi S of Nuevo Laredo, 28 Aug 1976, *Rogers 13476* (WUD); Highway 2, 5 mi E of jct. with Highway 85, S of Nuevo Laredo, 28 Aug 1976, *Rogers 13477* (WUD); 4 mi SW of Nuevo Laredo, 14 Nov 1958, *Rollins & Tryon 5802* (LL); Arroyo Coyote, 7 km Carretra Nacional, 1 Apr 1964, *Vazquiz 30* (TEX).

U.S.A. Texas. Cameron Co.: U.S. 83, 12 mi N of Brownsville, 18 Apr 1965, *Rios & Cavazos 262* (LL). Dimmit Co.: 5 mi N of Carrizo Springs, 16 Mar 1963, *Cabrera 80* (TEX). Duval Co.: Realitos, 17 Mar 1934, *Whitehouse 781* (NY). Jim Hogg Co.: 8 mi S of Hebbronville, 20 Mar 1969. *Correll 36801* (LL). Jim Wells Co.: 6 mi S of Alice, 20 Mar 1952, *Jones 699* (SMU). LaSalle Co.: near Encinal, 27 Aug 1976, *Rogers 13470* (WUD). Webb Co.: Laredo, 11 Mar 1944, *Crockett 5417* (LL). Zapata Co.: 13 mi N of San Ygnacio, 31 Jan 1954, *Shinners 17656* (SMU). The distribution is shown in Fig. 2.

LINUM **lundellii** Rogers, sp. nov. L. elongato affine, sed semper annuum, glandulis stipularibus foliorum superorum nullis, petalis circa 10 mm longis et stylis 3–4 mm longis. Type: *C. L. & A. A. Lundell 9894*, 2 Apr 1941, on gravelly hill, off U.S. 83, W of Sullivan City, Starr Co., Tex. (Holotype: LL).

Annual, essentially glabrous herb, 10–40 cm tall; leaves alternate, linear, 5–30 mm long, 0.5–1.5 mm wide; stipular glands absent above, moderately developed below; sepals linear-lanceolate to lanceolate, acute to acuminate, 4–12 mm long; petals obcordate, 7–12 mm long, yellow to orange-salmon, faintly banded near the base (Fig. 4c); stamens 4–5 mm long; anthers 1.0–1.5 mm long; styles 3.0–4.0 mm long; stigmas mostly dark-wine; fruit ovate, 3.3–4.0 mm high, 2.6–3.1 mm in diameter; seeds reddish brown, 2.5–2.7 mm long, ca. 1.1 mm wide; chromosome no. $n = 15$ (chromosome vouchers: *Rogers 13137*, 2 Jul 1964, 2 mi N of Roma, Starr Co., Tex.; *Rogers 13471*, 27 Aug 1976, 5 mi E of Laredo, Webb Co., Tex., both WUD). In addition to the type and the specimens cited for chromosome number, the following collections have been examined.

MEXICO. Nuevo Leon: ca. 15 mi SW of Galeana, 19 May 1934, *Mueller and Mueller 470* (TEX); 4 mi S of China, 6 Aug 1964, *Rogers 13189* (WUD). Tamaulipas: 5 mi SW of Reynosa, 29 Feb 1944, *Painter & Barkley 14412* (LL); ca.

10 mi SW of Reynosa, 6 Aug 1964, *Rogers 13190* (WUD); 2 mi W of Nuevo Guerrero, 28 Aug 1976, *Rogers 13478* (WUD).

U.S.A. Texas. Dimmit Co.: 2 mi N of Carrizo Springs, 3 Jul 1964, *Rogers 13142* (WUD); 3–4 mi NW of Carrizo Springs, 29 Aug 1976, *Rogers 13486* (WUD); 14 mi NW of Carrizo Springs, 29 Aug 1976, *Rogers 13488* (WUD). Hidalgo Co.: 11 mi W of LaJoya, 28 Aug 1976, *Rogers 13479* (WUD); La Joya, 9 Feb 1942, *Walker 48* (TEX). Jim Hog Co.: Arroyo Baluarte, Thompsonville, 15 Mar 1964, *Correll 29000* (LL). Starr Co.: ca. 1.5 mi N of Roma, 17 Mar 1966, *Correll 32270* (LL); below Falcon Dam, 17 Mar 1962, *Ramos* et al *7864* (TEX); near Falcon Dam, 2 July 1964, *Rogers 13138* (WUD); U.S. Highway 83, 3 mi SE of junction with farm road 2098, 28 Aug 1976, *Rogers 13480* (WUD); 3 mi N of Roma, 31 Jan 1954, *Shinners 17702* (SMU); Falcon State Park, 14 Mar 1968, *Wood 838* (TEX). The distribution is shown in Fig. 3.

DISCUSSION

Linum lundellii, except for vegetative features such as stature, amount of branching, and leaf size, is a very uniform species and may be readily distinguished from *L. elongatum*, the range of which overlaps that of *L. lundellii*, as well as from *L. rigidum* var. *filifolium* by style length, which is well correlated with other differences such as petal size and shape, anther size, and the absence of stipular glands at the bases of upper leaves. Its distinctiveness is supported by the results of attempted crosses with *L. elongatum* (128 crosses) and with *L. rigidum* var. *filifolium* (164 crosses), none of which produced functional seeds.

In *L. lundellii* the anthers are placed at about the same level as the stigmas (Fig. 4c). In garden-grown plants, by the time the flowers were well opened, pollen had already been deposited upon the stigmas. In these plants self-pollination was certainly the rule. In *L. elongatum* and *L. rigidum* var. *filifolium* the styles extend well beyond the anthers (Fig. 4a,b), and there are ordinarily a few hours (depending upon cloudiness and wind conditions) during which the anthers have dehisced, but pollen has not been shed. In the Michigan garden no insect pollinators were observed; these may be present in the natural range of the species. There is at least the opportunity for outcrossing. If cross-pollination fails, however, self-pollination is assured, since the intact corolla, before falling, ordinarily slips upward past the open anthers like an ascending collar, depositing pollen on the stigmas above.

Linum elongatum and *L. rigidum* var. *filifolium* appear to be closely related. It may be that some hybridization takes place between the two in the field. The results of experimental crosses between the two reflect this possibility; one or more rather weakly developed but mature seeds were produced in 14 of 136 crosses attempted. Of a series of features that differentiate the two, possibly none holds for every comparison of individual specimens. For example, most collections of *L. elongatum* are perennial. This is a very unusual character in the "*L rigidum* complex" of about twelve species. *Linum subteres* (Trel.) Winkler, of Utah and Nevada, is the only other which is

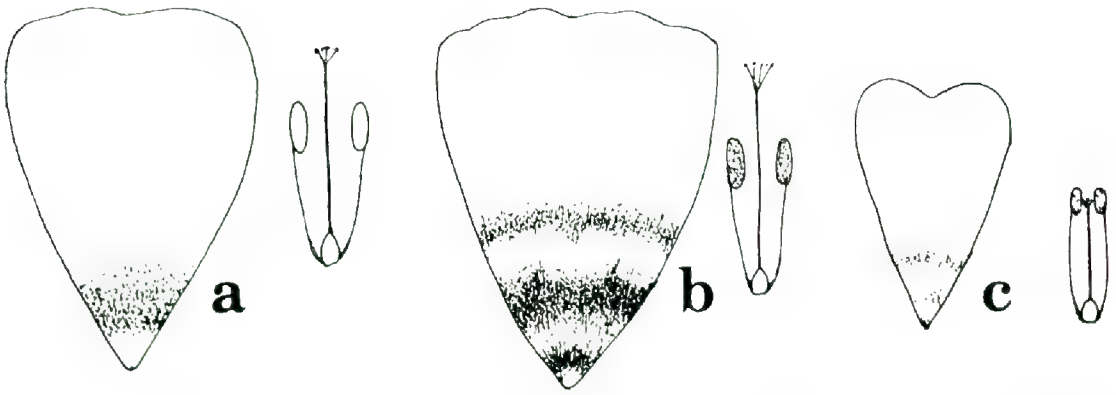


Fig. 4. Petal, stamens and pistil of *L. rigidum* var. *filifolium* (a), *L. elongatum* (b), and *L. lundellii* (c). All x 2.5.

consistently perennial. However, *L. elongatum* flowers the first year, and a number of herbarium specimens appear to be or are annual. In addition, two collections of *L. rigidum* var. *filifolium* are quite clearly perennial.

The petal coloration of *L. elongatum* makes this one of the most attractive of the flax species. The author's collections and the several dozen plants grown from their seed were uniformly colored in the manner described. Dried specimens, because of the fading of the pigments and because petals have frequently fallen if collections are made late in the day, do not always show petal color. In garden-grown plants, one individual (of about 40 plants), which otherwise had the characters of (and was identified as) *L. rigidum* var. *filifolium*, had the petal coloration of *L. elongatum*. Otherwise the two taxa were easily distinguished on this character alone. The attenuate sepals, which were the basis for the selection of the specific epithet for *L. elongatum*, can be used for the identification of most specimens, but there is enough variation in both taxa that some specimens would be difficult to place using that character alone.

Linum elongatum uniformly possesses stipular glands at the bases of the upper leaves; *L. lundellii* uniformly lacks them there, although they may be moderately developed at the bases of the lower leaves. Most collections of *L. rigidum* var. *filifolium* have stipular glands also, but with the exception of a single collection from near Del Rio, none of the specimens from Val Verde, Kinney, or Maverick Counties have stipular glands. This may provide another distinguishing feature between *L. rigidum* var. *filifolium* and *L. elongatum*, if one is needed, in the region of closest geographical proximity of the two taxa. Baesd upon the specimens thus far examined, the range of *L. rigidum* var. *filifolium* is distinct from those of either *L. elongatum* or *L. lundellii*, being restricted in Texas to northwestern Maverick Co. and northwestward, while *L. elongatum* and *L. lundellii* are found only from Dimmit County southeastward.

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REDISCOVERY OF *SPIRANTHES PARKSII* CORRELL

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Spiranthes parksii Correll was described in 1947 on the basis of specimens collected by H. B. Parks along the Navasota River (Democrat Bridge) in Brazos County, Texas (Correll, 1947). It appears that the late Dr. Parks was the only person to have seen a living plant. Correll (1950) and Correll and Johnston (1970) reported that this species was endemic to Brazos County but recent attempts to find it there have been unsuccessful (Luer, 1975; D. S. Correll and M. C. Johnston, pers. comm.). *Spiranthes parksii* is the only North American orchid not illustrated with a photograph in Luer's (1975) recent work on the North American orchids. It is one of the 20 species listed by Ayensu (1975) in an attempt to identify those North American orchids in serious danger of extinction. *Spiranthes parksii* is not only one of the rarest North American orchids, it is also one of the least well known.

While collecting data from the AMES orchid herbarium (Harvard University) in 1975, I noticed a sheet labelled "*S. cernua*, Hy College—Navasota, 10 miles west of Navasota R. bridge on hwy no. 6, *H. B. Parks*, 27 Oct 1945" (AMES 63043). This sheet had 12 plants mounted on it, some referable to *S. cernua*, others to *S. parksii*. The type of *S. parksii* (AMES 63039) was available for comparison.

On 25 Oct 1978, we had an opportunity to explore the Post Oak Savanna northwest of Navasota. Local residents reported that it had been a dry summer and perhaps for this reason *Spiranthes* spp. were not easily found. *S. cernua* (L.) L. C. Rich. occurred sparingly along margins of ponds and streams. Both the normal white open-flowered plants and more or less peloric, yellow closed-flowered plants were seen. A few *S. lacera* (Raf.) Raf. var. *gracilis* (Bigel.) Luer were found on dry sandy banks, all past anthesis.

Exploring the open banks of a temporary stream surrounded by scattered oaks (*Quercus stellata, Quercus marilandica*) and Beauty-berry (*Callicarpa americana*), several *Spiranthes* orchids were found among the open cover of grasses and forbs (Fig. 1). Some of these were closed-flowered *S. cernua* but others scattered among them had open greenish-white flowers with relatively short rounded petals and an ovate, distally truncate lip. The floral bracts of these plants also differed in having distinctly whitened tips. A close examination and dissection of a few flowers indicated that these plants

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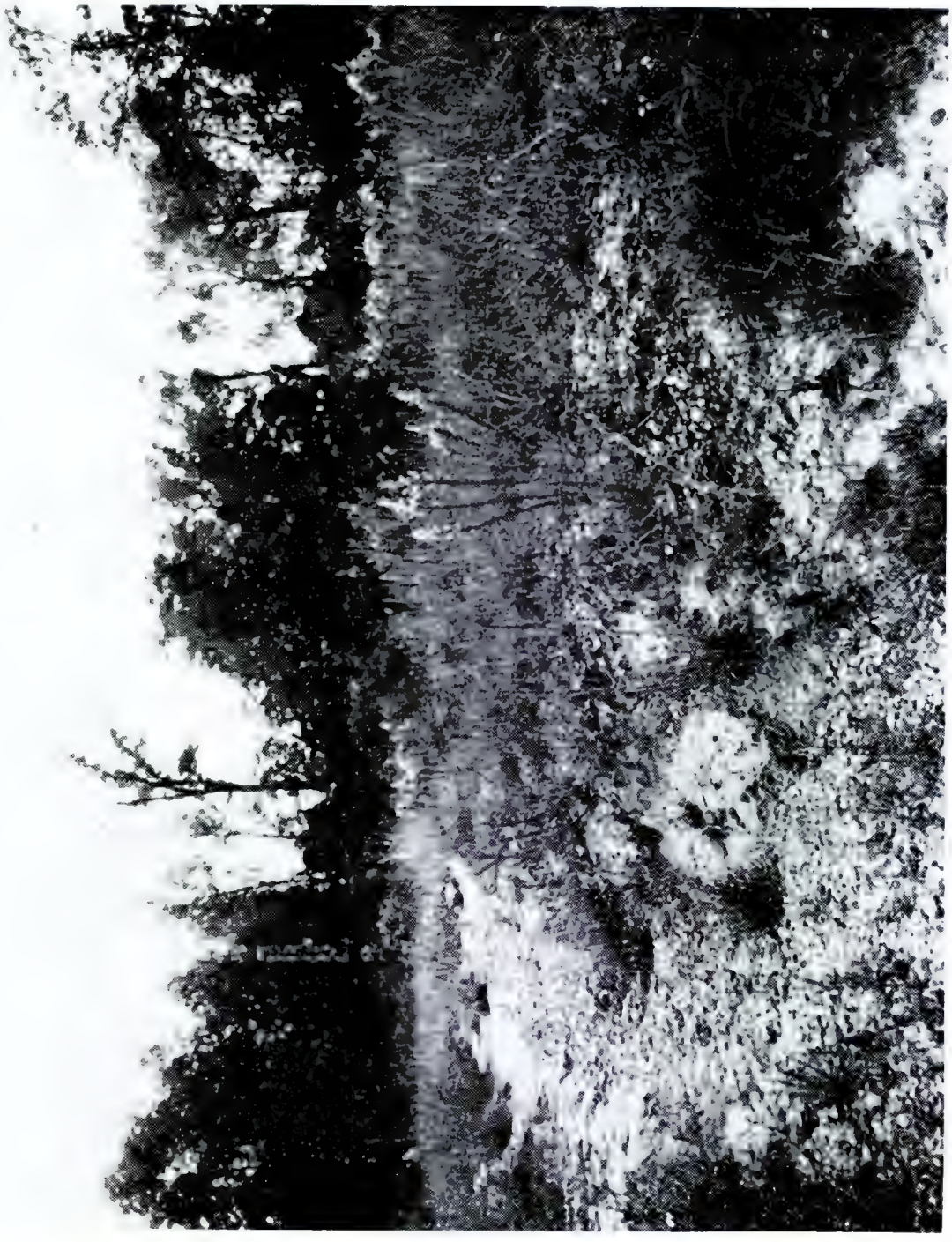

Fig. 1. Open grassy meadow habitat of *S. parksii* along a temporary stream. Dominant plants include *Schizachyrium scoparium* var. *frequens*, *Sporobolus junceus*, and *Eupatorium compositifolium*. Photographed 25 Oct 1978, ca. 19 km NW of Navasota, Brazos Co., Texas.

were beyond any doubt referable to *S. parksii*, the description and original illustrations of which we had with us.

The dominant plant associates here included *Schizachyrium scoparium* var. *frequens, Panicum brachyanthum, Aristida longispica, Sporobolus junceus, Eupatorium compositifolium*, and *Linum medium* var. *texanum. Chrysopsis pilosa* and *Ascyrum hypericoides* var. *hypericoides* were also present.

A few hundred yards away we found more plants of *S. parksii* on the banks of another temporary stream (Fig. 2). The vegetation here was again an open oak woodland (*Q. marilandica, Q. stellata, Q. nigra*) but with scattered thickets of *Forestiera ligustrina, Callicarpa americana* and *Ilex vomitoria. Spiranthes parksii* occurred both on the tops of the banks in open sand with a sparse cover of grasses, and on the sides of banks sometimes in the shade of thickets. Dominant associates here included *Andropogon ternarius, Andropogon virginicus, Aristida longispica, Muhlenbergia capillaris, Linum medium* var. *texanum, Eupatorium compositifolium*, and *Smilax bona-nox* var. *hastata. Paspalum setaceum* var. *stramineum, Ascyrum hypericoides* var. *hypericoides* and *Drosera annua* were also recorded as associates at this location.

In all, seven plants were found at the first locality and 13 at the second. Soil collected from about the roots of several plants was found to have a pH range of 4.0–5.8, with most readings between 4.5 and 4.9.

Since the flower color of *S parksii* has not been described, various floral parts were compared with the Royal Horticultural Society Colour Chart (1966). The general flower color (*i.e.* the conspicuous perianth parts) varies from white (155A) to light yellow-green (154D). The dark green color of the ovary (144A–B) extends onto the basal perianth parts for 0.5–2.0 mm. Lateral petals vary from whitish (155A) to yellow-green, (144B-C, 154C). The midvein region is slightly greenish (145C) in white lateral petals and darker green (144A) in greenish lateral petals. The central portion of the lip varies from yellow (2D) to yellow-white (158B–C) and yellow-green (150C, 151C 154C). The calli are white (155A–D). The stigmatic surface is green (144B, C) but the proximal stalk of the column is white (155A–D) and the pollen masses are yellow (9B) to light yellow-orange (14C). The darkest green color in the flowers occurs in the basal perianth parts, in the lateral petals and on the stigmatic surface. The remainder of the plant is green (144A) except for the floral bracts which are white 1.5–3.0 mm from the tip.

Although no insects were observed pollinating the flowers, the pollinia are easily detached, and the stigmatic surface is viscid, the pollen readily adhering to it. A drop of glucose-rich liquid is secreted near the base of the lip. These characteristics suggest insect pollination, but the ovaries can enlarge and develop seed without pollination. Brown and withered flowers on several plants had the pollen masses intact and the stigmatic surface had not received any pollen. The ovaries of these withered flowers contained

Fig. 2. Habitat of *S. parksii* (lower center). Several plants were growing on the high banks of a temporary stream in the open with *Andropogon ternarius*, *Andropogon virginicus*, *Muhlenbergia capillaris*, and others (see text). The surrounding trees are *Quercus marilandica*, and *Quercus stellata*. Photographed 25 Oct 1978, ca. 19 km NW of Navasota, Brazos Co., Texas.

Fig. 3. Flowers of *S. parksii* showing relatively short lateral petals and white-tipped floral bracts. Photographed 25 Oct 1978, ca. 19 km NW of Navasota, Brazos Co., Texas.

immature seeds of which 80–90% were polyembryonic. The occurrence of polyembryony in *Spiranthes* is associated with adventitious embryony (Swamy, 1948; Catling, unpublished data).

With its rounded or oval lateral petals (4.5–6.7 mm long) much shorter than the sepals (5.0–8.0 mm long), and a distally truncate, erose-margined lip (5.0–7.0 mm long), *S. parksii* appears to be a very distinctive species. The loosely flowered spike and absence of leaves at flowering time also help to separate *S. parksii* from other sympatric Spiranthes spp. These features are well illustrated in the drawings provided by Correll (1947, 1950) and in the accompanying photograph (Fig. 3). The green marking along the center of the lateral petals and the white-tipped floral bracts are helpful in field identification. *S. parksii* keys out readily in keys provided by Correll (1950) and Correll and Johnston (1970).

Correll (1947) thought that *S. parksii* had no close allies in our flora, its affinity being with several Mexican and Central American species. Its taxonomic status and evolutionary relationships are indeed a matter of great interest.

In view of the general rarity of the plant, it seems desirable to document any future discoveries with photographs, measurements and detailed field notes rather than a large series of collected specimens.

We thank D. S. Correll and M. C. Johnston for commenting on the manuscript.

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CLEMATIS PITCHERI T. & G. VAR. *DICTYOTA* (GREENE) DENNIS, COMB. NOV. (RANUNCULACEAE).[1]

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Clematis pitcheri T. & G. is a highly variable, wide-ranging species distributed on a northeast to southwest clinal axis extending from western Indiana, Illinois, and eastern Iowa south to Hidalgo and Queretaro, Mexico (Dennis, 1976). It is distinguished from other closely related taxa by its non-plumose achene tails. In Gray's Synoptical Flora of North America (1895), Robinson recognized four varieties within the *C pitcheri* complex. More recently Erickson (1943) recognized only two varieties: *C. pitcheri* T. & G. var. *pitcheri*, which includes those plants with pinnate leaves having leaflets 4–10 cm long and ovate sepals, and *C. pitcheri* var. *filifera* (Benth.) Robinson, which is distinguished from the type variety by having pinnate-ternate leaves having leaflets less than 4 cm long and lanceolate sepals. *Clematis pitcheri* var. *pitcheri* was ascribed a distribution from Indiana to eastern Nebraska and south to Texas and var. *filifera* was reported to occur along banks of streams and in canyons of western Texas, New Mexico and Mexico.

In a recent biosystematic study of *Clematis* subsection *Viornae* (Dennis, 1976) it was concluded that Erickson's (1943) recognition of two varieties of *C. pitcheri* on the basis described above is taxonomically unsound. These characters (leaf size, degree of leaf division and flower shape) vary considerably within all members of the subsection suggesting polymorphism and ecotypic variation rather than variation indicative of speciation. However, within *C. pitcheri* var. *filifera* sensu Erickson there is a morphologically recognizable element that was treated by Erickson (1943) as a synonym of var. *filifera*. This element is *C. dictyota* Greene, which is herein recognized as a variety of *C. pitcheri*.

CLEMATIS PITCHERI var. **dictyota** (Greene) Dennis *stat. et comb. nov.* Basionym: *Clematis dictyota* Greene, Pittonia 5:133. 1903. TYPE: US, Texas, Limpia Canyon, 26 Apr 1902, *Tracy and Earle 256* (Holotype, ND, as photo MO!; Isotypes, TEX! US!). [*Viorna dictyota* (Greene) Heller.] Leaflets generally thicker, smaller and more divided than var. *pitcheri*. Sepals light to brownish purple without, tips recurved

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and slightly expanded. Filaments and connectives (including extended apex) essentially glabrous or occasionally with a few erect trichomes just below the anthers or along the connective or its extended apex.

Clematis pitcheri var. *dictyota* is restricted to soil accumulations among boulders, crevices of rock formations, and stream banks of the Trans Pecos region of western Texas and adjacent New Mexico and Mexico. It is distinguished from var. *pitcheri* by its glabrous filament and anther connectives. Erickson (1943) did not note this character and referred all small leaved plants of Texas and Mexico with both glabrous and pubescent filaments and connectives to *C. pitcheri* var. *filifera.* Correll and Johnston (1970) used pubescence on filaments as a key character to distinguish west Texas populations as *C. filifera* Benth. However, examination of the type specimen of *C. filifera* Benth. [Mexico. Prope Leon, 1839. *Hartweg 1590* (Holotype, K!; Isotype, LD!)] revealed that its filaments were pubescent. Since the most consistent taxonomic character distinguishing the Trans Pecos populations is the absence of trichomes on the filaments, the name *C. filifera* cannot be applied to these plants. Review of previously published names and study of type specimens indicate that *C. dictyota* Greene is the appropriate element upon which to base a taxon representative of the Trans Pecos populations. It was described from the region and its type specimen has glabrous filaments. Varietal status for the plants of the Trans Pecos region based on the name *C. dictyota* is therefore proposed. All small-leaved plants in this complex occurring in New Mexico, Mexico and Texas that have non-plumose achene tails and pubescent filaments, (i.e. *C. filifera* Benth. sensu stricto) are referred to *C. pitcheri* var. *pitcheri.*

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FIELD NOTES ON NIGERIAN *STRIGA* (SCROPHULARIACEAE)

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Striga is a palaeotropical genus of perhaps as many as 50 species, although the genus has not been monographed. Like many Scrophulariaceae, *Striga* is root parasitic. In fact, several species are of great economic importance, particularly in the semi-arid tropics. In the rain fed areas of subsaharan Africa *S. hermonthica* (Del.) Benth. is an ubiquitous weed in guinea corn (*Sorghum bicolor*) fields. In some areas it is the single most serious parasite of this main crop of subsistence farmers. Millet (*Pennisetum typhoides*) may also be attacked by this species. *Striga gesnerioides* causes damage to a variety of crops, including legumes and tobacco. Witchweed (*S. asiatica*) is the most widespread species in the genus, extending across Africa, the Indian subcontinent, and into Indonesia. It parasitizes corn, rice, sugar cane, and other members of the Poaceae. *Striga angustifolia* (Don.) Saldanha (= *Striga euphasioides* Benth.) is an important parasite on sorghum in India. These and a few other species are briefly discussed in Hosmani (1978).

Two species have been accidentally introduced to the New World. In the 1950s *S. asiatica* (L.) Kuntze (= *S. lutea* Lour.) was discovered in the Carolinas. It is presently known from several counties in southeastern North Carolina and adjacent South Carolina. It is now the object of a federal quarantine and eradication program. Very recently *S. gesnerioides* (Willd.) Vatke was discovered in Polk Co., Florida (Wunderlin, Musselman and Shuey, 1979). The extent of this infestation is being investigated.

The most useful aid to identification of African material is found in Hepper (1963). Characters of diagnostic value in separating species include number of ribs in the calyx, indumentum, relative size of calyx and of corolla tube, size of the bract subtending each flower, and flower color. Like several other genera of parasitic angiosperms that exhibit reduction of vegetative parts, floral characters are the main basis of taxonomic differences in *Striga*. Plants are often confused in the field, however, particularly *S. aspera* and *S. hermonthica*.

Despite its agronomic importance, very little information of a descriptive

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nature is available for the genus, especially for those species that are not serious pathogens. The purpose of this paper is to record field observations on several species of *Striga* observed in Nigera in October and November 1978.

Specimens were collected from Kazaure in northern Nigeria near the border with Niger and southeast along the main road south to Mokwa. This transect crosses several rainfall isohyets from 750 mm/year in the north to 1500 mm/year near Mokwa and corresponds approximately to the vegetational zones known as Sudan Savanna, Northern Guinea Savanna, and Southern Guinea Savanna.

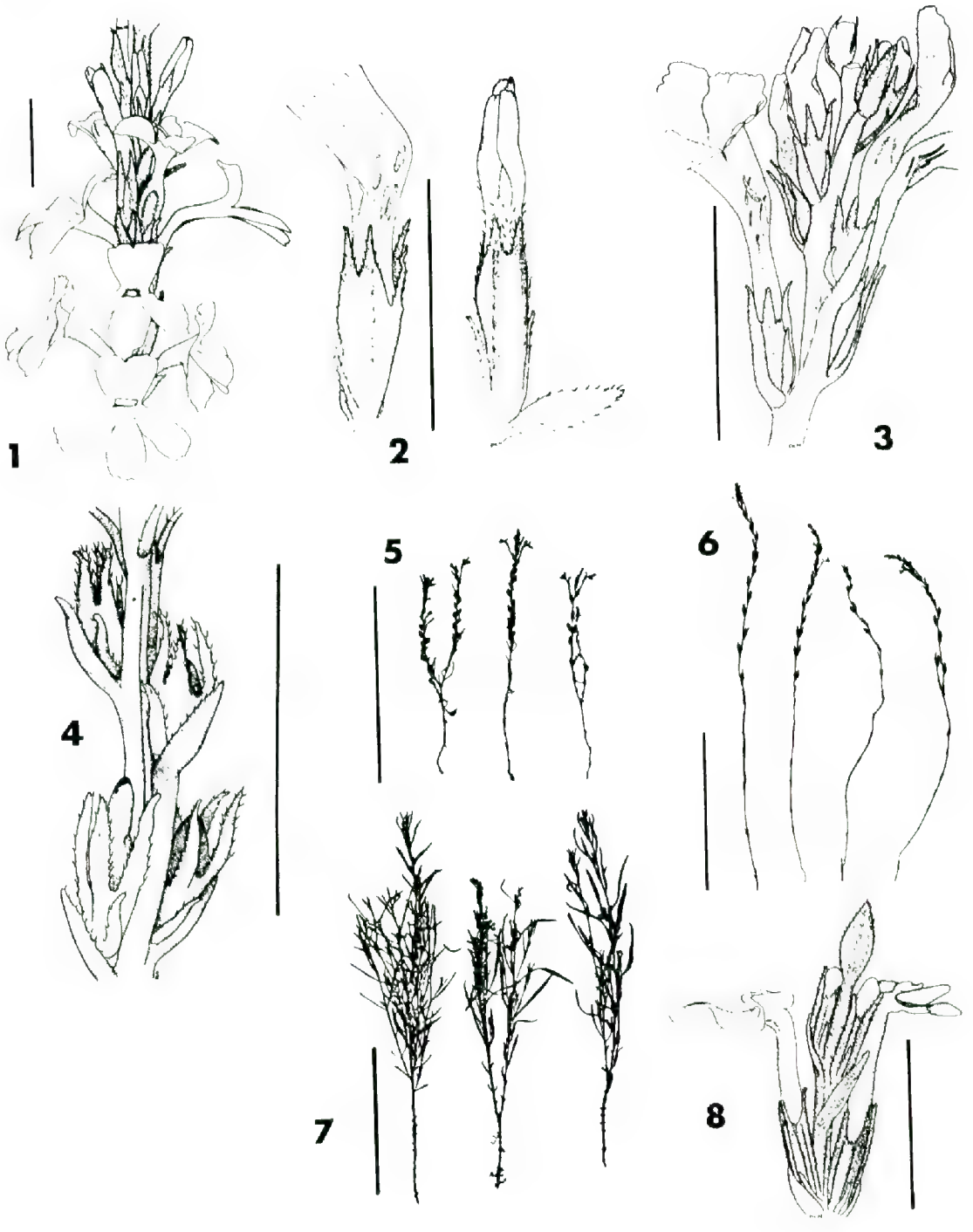
All species of *Striga* are considered noxious weeds in the United States and are under a federal plant quarantine. Therefore, all dried specimens from Nigeria were devitalized by treatment with ethylene oxide at 25 lbs/1000 cu. ft for 2 hours at 70°F or above by the Animal and Plant Health Inspection Service, Plant Protection and Quarantine Programs. These specimens are deposited in the Old Dominion University Herbarium (ODU). Drawings were prepared from FAA preserved material and from Kodachromes. Silhouettes are from actual specimens.

STRIGA HERMONTHICA (Del.) Benth.

This is a strikingly beautiful species with large pink flowers. Of the six species examined, only *S. hermonthica* has more than two corollas open per inflorescence branch and flowers that last more than one day (Fig. 1). Widespread throughout the drier regions of Africa, it is quite variable. A cursory examination of populations parasitizing sorghum at Musasa and Zaria (Both Kaduna State, Nigeria) revealed the following corolla variations: upper lobe entire to almost bifid, orifice of throat white or pink, and lower lobes deeply toothed to entire. The extent of this variation among populations remains to be determined as does its source. Of greater agronomic importance is the physiological variation within the species. Preliminary work by C. Parker (personal communication) of the Weed Research Organization indicates that *S. hermonthica* may exist as two strains—one attacking millet, the other sorghum. In the present study "millet" *S. hermonthica* was examined at Mokwa and appeared morphologically identical to that growing on sorghum. Like other species of *Striga*, little is known regarding floral biology despite the potential value of such work on a parasite that reproduces entirely from seed. However, preliminary work by Parker (personal communication) suggests that at least some populations are distinctly outcrossing.

STRIGA ASPERA (Willd.) Benth.

Striga aspera and *S. hermonthica* are superficially quite similar and may be found growing together. They may be readily separated, however, on the basis of bract size and corolla pubescence. The bract subtending the



(Scale for silhouettes equals 10 cm, for drawings 1 cm)

Fig. 1. *Striga hermonthica*, portion of inflorescence.

Fig. 2. Calyces of *S. hermonthica.* Figure on right shows lateral bract. Smaller structures are bracteoles.

Fig. 3. *S. aspera* inflorescence; *Musselman and Mansfield 5524.*

Fig. 4. *S. aspera*, diminutive plant from Kuffena Rock; *Musselman and Mansfield 5530.*

Fig. 5. Same as Fig. 4, showing aspect.

Fig. 6. *S. asiatica*, Tegina; *Musselman and Mansfield 5531.*

Fig. 7. American strain of *S. asiatica* from U.S.D.A. Witchweed Laboratory.

Fig. 8. Flowers of *S. asiatica; Musselman and Mansfield 5531.*

flower of *S. aspera* is almost as long as the *calyx* (Fig. 4) while the bract of *S. hermonthica* is much shorter than the calyx (Fig. 2). The entire external portion of the corolla of *S. aspera* is covered with glandular hairs (Fig. 2) while *S. hermonthica* lacks glands (Fig. 2). Additional differences include the more abrupt angle of the corolla tube of *S. hermonthica* (Fig. 2, left) and the larger lower leaves. The two species are also somewhat different in their ecology, *S. aspera* being more commonly found in natural grasslands and *S. hermonthica* as a weed in sorghum. However, *S. aspera* has also been found to parasitize sorghum but has been invariably assumed to be *S. hermonthica* in such cases. Plants of *S. aspera* from Kuffena Rock, a massive granite Inselberg near Zaria, were diminutive but possessed the characteristic bracts and pubescence (Fig. 5).

STRIGA ASIATICA (L.) Kuntz

The most widely distributed of all species in the genus and a serious pathogen throughout most of its range, *S. asiatica* is not a problem in Nigeria despite the planting of corn (*Zea mays*) on a large scale in some places. Plants were growing on an ironstone outcropping near Tegina, Kaduna State, in a stand of native grasses. The overall form of these plants was quite different from that of the strain introduced to the United States (cf. Fig. 6 and 7). The Nigerian plants were much more pubescent than the American strain (Fig. 8). The American strain has recently been shown to be autogamous (Nickrent and Musselman 1979). While more careful studies are necessary, it appears that plants in the Tegina population were not autogamous.

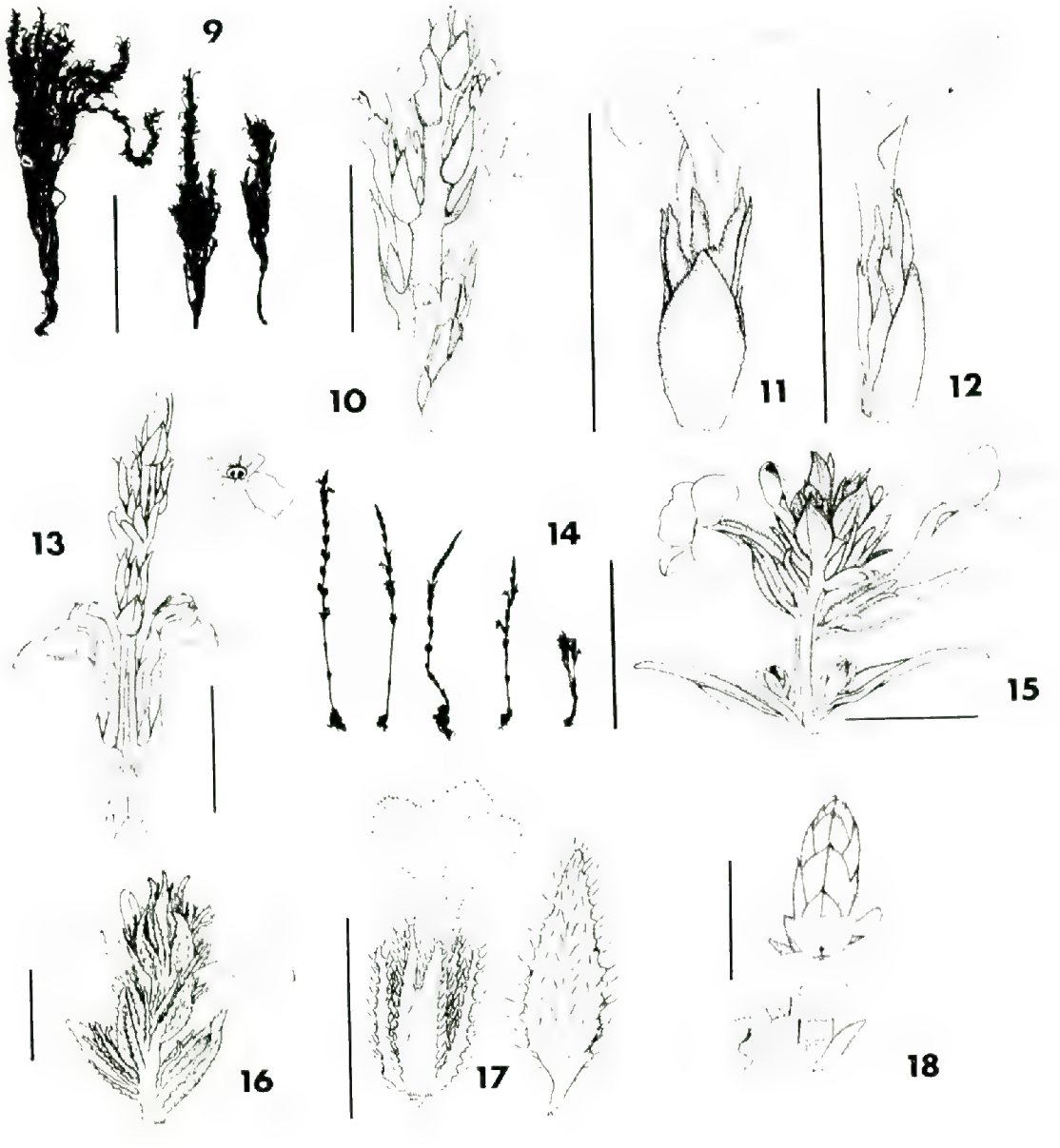
STRIGA GESNERIOIDES (Willd.) Vatke

Unlike the other species in this study, *S. gesnerioides* does not parasitize grasses. It is a serious parasite of cowpeas (*Vigna unguiculata*). In other parts of its range it is known to parasitize tobacco (Hosmani 1978). Two distinct strains were observed in this study. The first is the widespread cowpea strain (Figs. 9-12), the second was seen only at Mokwa, Niger State and was parasitizing a weedy legume *Tephrosia pedicellata* (Figs. 13, 14). To our knowledge, there is no formal taxonomic difference between these two strains. They are, however, quite different in some aspects of their morphology and growth habit. The flowers of the Mokwa strain were more pink than the cowpea strain, the size of the bract was also different (cf. Fig. 9 with 13). Most, striking, however, is the general habit of the plant. The Mokwa strain only rarely branched (Fig. 14), while the cowpea strain branched repeatedly at the ground level (Fig. 9).

The strain of *S. gesnerioides* recently introduced into Florida most closely resembles the Mokwa strain (Wunderlin, Musselman and Shuey 1979).

STRIGA MACRANTHA Benth.

Unlike the four species discussed above, *S. macrantha* and *S. klingii* are



(Scale for silhouettes equals 10 cm, for drawing 1 cm)

Fig. 9. Cowpea strain of *Striga gesnerioides*, Kazure; Musselman and Mansfield, 5526.

Fig.10. Inflorescence of cowpea strain.

Figs. 11 and 12. Individual flowers of cowpea strain of *S. gesnerioides* show size of bract relative to calyx.

Fig. 13. Mokwa strain of *S. gesnerioides*; Musselman and Mansfield, 5534.

Fig. 14. Mokwa strain of *S. gesnerioides* showing aspect.

Fig. 15. Inflorescence of *S. macrantha*, Tegina; Musselman and Mansfield, 5522.

Fig. 16. Inflorescence of *S. klingii*, Mokwa; Musselman and Mansfield, 5533.

Fig. 17. Flower and bract of *S. klingii.*

Fig. 18. Face view of corolla, *S. macrantha.*

not known to be of any economic importance. *Striga macrantha* was collected near Tegina, Kaduna State, on an ironstone outcrop where it was growing with *S. asiatica* in rocky soil amongst grasses. It was up to 1.5 m tall and had large white flowers, apparently the only Nigerian species characterized by that corolla color. The flowers are crowded on a dense spike (Figs. 15, 18) and the bracts and calyces are densely pubescent with both glandular and non-glandular hairs.

STRIGA KLINGII (Engl.) Skan

Great variation in the size of plants were observed in this species. It is apparently a characteristic plant of the dense *Hyparrhenia* (Poaceae) grasslands of the Southern Guinea Savanna. When growing amongst tall grass, the plants are quite short while those on the margin of the grasslands are considerably more robust. This species is characterized by small pink flowers in crowded spikes and hispid hairs on the large bracts (Fig. 16, 17).

A workshop was held in Khartoum, Sudan in November 1978 on *Striga* and *Orobanche.* Of major concern were *S. asiatica, S. angustifolia*, and *S. hermonthica* although some time was devoted to the *S. gesnerioides* problem. The emphasis of the meeting was on control in its broadest sense including breeding for resistance/tolerance in host species. At present one of the more promising means of control is the use of germination stimulants that cause seeds of the parasite to germinate without a host—thus committing "suicide". A group of compounds developed at Sussex University are now being tested for their efficacy in this regard. A summary of this meeting and suggestions for future work will be published in PANS. One critical area includes research on taxonomy and host specificity.

Thus, much opportunity exist for taxonomic research in the genus *Striga.* Unfortunately for American botanists interested in conducting a biosystematic study, the species are under federal quarantine and cannot be grown in the United States without special permission.

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NOTES

HYPTIS MUTABILIS (LABIATAE) IN SOUTHEASTERN UNITED STATES.—In September 1977 I collected, in far southeastern Louisiana, a member of the Labiatae that was not at the site when I was there in summer from 1963 to 1972. After some struggle through a scant and not-too-helpful literature, I finally identified the species as *Hyptis mutabilis* (L. Rich.) Briq., a weedy plant widespread in warm America and new to Louisiana.

This paper is the result of my curiosity concerning *H. mutabilis*. It summarizes literature on the species, provides illustrations of the species (there apparently are no good, easily accessible illustrations in the literature), and gives data on its occurrence in southeastern United States.

By the most recent monographer of *Hyptis* (Epling 1949), *H. mutabilis* was recognized as a single, highly variable species not divisible into infraspecific taxa (Epling 1949) although in older works it was treated as a species with several varieties or even as several species (Epling 1933, 1936). Its representatives in the United States were treated as two species or as two varieties of one species. Such distinctions fail when many specimens are examined.

In Epling's first work on *Hyptis* (Epling 1933), he used "var. *spicata* Briq." for those representatives of *H. mutabilis* in the West Indies and the Caribbean coastal regions. (Presumably var. *spicata* is what today would be called var. *mutabilis*, although this point is not resolvable from Epling's prose; he never was able to locate the holotype of *H. mutabilis*.) In his synopsis of South American Labiatae, Epling (1936) continued to use "var. *spicata* Briq." in the same way. However, he commented: "I have sought to indicate here the principal modes of variation within this puzzling complex [*H. mutabilis*]; however, it is impossible to refer numerous specimens with certainty to any one group [variety], and I hesitate to cite specimens within the divisions [varieties] I have indicated." In Epling's last work on *Hyptis* (Epling 1949), he reduced *spicata* and other varieties recognized in 1933 and 1936 to synonymy under *H. mutabilis*. Abandoning efforts to distinguish infraspecific taxa, he wrote: ". . . parece que no posse razas bien definidas" (he did, however, refer to his 1936 work where "La indiqué . . . las variantes principales"). In all his papers, he recorded *H. mutabilis* only from Florida in southeastern United States.

The author of the epithet *mutabilis* is frequently and incorrectly given as "A. Rich." (e.g., in Epling 1933, 1936; Small 1933). The actual author, Louis Claude Marie Richard (usually cited as "L. Rich." or "L. C. Rich."), published *Nepetha* [sic] *mutabilis* in 1792. Louis eventually turned his attention from *Nepetha* and fathered Achille Richard ("A. Rich."), who was not born until 1794.

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Hyptis mutabilis was recorded from southeastern United States as early as 130 years ago. Bentham (1848), under *H. spicata*, included the note "Florida (h. Torrey!)," evidently based on a collection (or possibly two) he had received from the herbarium of John Torrey. Two undated sheets—one at NY, one at GH—appear to be duplicates of the specimen(s) Bentham saw; they bear, among equivocal collection data and in handwriting, the annotation *H. spicata* and the notes "fide Bentham" (NY) and "Benth. in lit." (GH).

Gray (1878) ascribed *H. spicata* to "S. Florida." Chapman (1889) reported it from "Tampa and Jacksonville, Florida"; he gave the same distribution later (Chapman 1897), but the word "introduced" was added without explanation (and possibly without justification). Small (1903) recognized, under the name *Mesosphaerum*, two species in the *mutabilis* complex: *Mesosphaerum spicatum* and *M. mutabile*. The former was ascribed to Florida and Alabama, the latter to Florida. (I cannot verify, through herbarium specimens, the presence of *H. mutabilis* in Alabama that early.) Small later (1933) withdrew the Alabama record: using the name *Hyptis*, he cited *H. mutabilis* only from Florida and said, of *H. spicata*, "not now definitely known from our range."

More recently, a good account of *H. mutabilis* is that by Standley and Williams (1973), who gave a detailed description of the species but did not ascribe it to conterminous United States at all. Long and Lakela (1971) gave the range as "Fla. to Va."

The specimens of *H. mutabilis* I have seen suggest that, in southeastern United States, this species was originally—and for about a century—known only from Florida. From that state it has, in the last 3.5 decades, spread northward and westward, reaching Louisiana very recently.

The earliest specimens of *H. mutabilis* available to me from southeastern United States (herbarium of John Torrey, NY, GH) were, as indicated above, collected in Florida before 1848. All other pre-1900 specimens are from Florida. Indeed, the earliest non-Florida specimen I saw was collected in southeastern Virginia in 1939 by Fernald and Long. That this specimen represents a non-persistent introduction is suggested by the facts that (1) it is the only Virginia collection I saw and (2) the collection locale is separated by 500 miles from the main U.S. range of the species. The northward and westward spread of *H. mutabilis* can be seen in exsiccata: the earliest *western* Florida (i.e., the Panhandle) collection I saw is from 1897 (the species was only rarely collected there until the 1940s and later); the earliest Georgia collection, 1940; Alabama, 1952; Mississippi, 1968; and Louisiana, 1977 (my collection was made just a few hundred feet west of the Louisiana-Mississippi border, which the species had obviously just crossed in its westward push. The documented distribution of *H. mutabilis* in southeastern

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Fig. 1. *Hyptis mutabilis*. Documented distribution in southeastern United States (Virginia locale omitted).

United States is shown in Fig. 1.

Available specimens of U.S. *H. mutabilis* suggest that the species has become much commoner in recent decades. The decade-distribution of specimens seen by me is as follows: pre-1848, 1 collection (possibly 2); 1850s, none; 1860s, none; 1870s, 2; 1880s, 1; 1890s, 9; 1900s, 5; 1910s, 1; 1920s, 1; 1930s, 2; 1940s, 7; 1950s, 16; 1960s, 43; and 1970s, 34 (through 1976 except my 1977 Louisiana specimen).

It is, of course, possible that specimen-based data on spread and abundance of *H. mutabilis* represent vagaries of collection and collectors rather than biological verities. But the data nevertheless strongly support my speculations.

Of the 127 conterminous U.S. collections of *H. mutabilis* I have seen, 93 are from Florida, 21 from Georgia, 6 from Alabama, 5 from Mississippi, 1 from Louisiana, and 1 from Virginia.

Fig. 2. *Hyptis mutabilis*. Flower (left) and fruiting calyx (right) (based on sketches accompanying *Curtiss 5112*, Jacksonville, Florida, NY). The vertical line represents 0.5 cm.

Hyptis mutabilis occurs mostly in disturbed places (e.g., roadsides, railroad yards, orchards, gardens, lake shores, river banks, fallow fields, ballast ground, thickets, and grazed areas). Some label data, though, suggest that it grows also in less disturbed habitats (e.g., stabilized dunes, hardwood or softwood forests, and hammocks). It is at home in moist or dry soil and in sun or shade. The method of its dissemination is unknown. No label data or literature reports suggest that *H. mutabilis* is a troublesome weed.

My Louisiana collection (St. Tammany Parish: 8 mi SE of Slidell along hwy. 190, 8 Sep 1977, *Thieret 50223*, KNK) was made from a colony of about 25 plants in a roadside weedy area bordering a channel of the Pearl River. Associates were mostly grasses, including *Paspalum* spp., *Cenchrus incertus*, and *Eragrostis oxylepis*. I especially noted two characteristics of the specimen I collected. First, its corollas, though small, were relatively showy, being bright purple with white blotches; and second, its foliage, crushed, had an aroma so delightful that *H. mutabilis* is certainly one of Louisiana's best-smelling mints, perhaps second only to *Satureja georgiana*.

The best identifying characteristic for *H. mutabilis is the calyx* (Figs. 2, 3). About 1.5–2.0 mm long, and campanulate in flower, it enlarges consider-

Fig. 3. *Hyptis mutabilis*. Section of fruiting inflorescence (*Mitchell 350*, Jackson Co., Florida, FSU). The vertical line represents 1 cm.

ably and quickly in fruit, becoming as much as 7.5 mm long and tubular. The 10 longitudinal veins increase in prominence, and strong cross veins develop to connect them. The accrescent calyx was first noted by Richard

(1792), the describer of the species, who wrote, "calycibus defloratis elongatus"; the characteristic was probably the basis for the epithet *mutabilis*.

The following description of *H. mutabilis* is based primarily on specimens, secondarily on literature.

Fig. 4. *Hyptis mutabilis*. Section of plant with dense inflorescences (*Duncan 17187*, Wayne Co., Georgia, GA). The vertical line represents 4 cm.

Plants herbaceous, erect, to 2.2 m high, often much branched, the branches glabrous to villous. Leaves membranaceous, 2.0–18.0 cm long, narrowly to broadly ovate to rhombic (rarely subrotund or even reniform), acute to acuminate at the apex, attenuate, cuneate, truncate, or subcordate at the base,

Fig. 5. *Hyptis mutabilis*. Section of plant with interrupted inflorescences (*Shuey 1688*, Polk Co., Florida, USF). The vertical line represents 4 cm.

finely to coarsely crenate to serrate, sometimes doubly so, variously pubescent to glabrate, passing abruptly or gradually into bracts; petioles 0.5–8.0 cm long. Flowers sessile to very short pedicelled, in bracteate verticels, these arranged in dense or interrupted (Figs. 4, 5), leafy or naked, terminal, spiciform inflorescences 3.0–20.0 cm long; bracts ovate to elliptic, acute to acuminate, prominently nerved. Calyx tubular to narrowly campanulate and 1.5–2.0 mm long at anthesis, tubular, reticulate-veined, and to 7.5 mm long in fruit, the teeth subulate to setaceous, erect, 0.7–1.2 mm long. Corolla 3.0–5.0 mm long.

I am grateful to the curators of the following herbaria for loan of specimens: A, FSU, GA, GH, MISS, NCU, SMU, TEX, US, and USF. Dr. Carroll E. Wood, Jr., gave help with the literature.—*John W. Thieret, Faculty of Biological Sciences, Northern Kentucky University, Highland Heights, 41076.*

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TRILLIUM PUSILLUM (LILIACEAE) IN MISSISSIPPI—*Trillium pusillum* Michx. is apparently one of the rarer species of the eastern United States. Roe (1978) considers the species to consist of four more or less disjunct populations probably of varietal status. His map shows a wide distributional gap between South Carolina and Texas, which has in part been

filled by recent collections from Sumner Co., Tennessee and Madison Co., Alabama (R. Kral, pers. comm.). We here report *T. pusillum* from Mississippi, thus further bridging this disjunction.

In May 1978 we first collected plants of an unknown *Trillium* with pedicellate fruit from Jones Co., Mississippi. It was initially noted as being somewhat different from all previously known species of the genus in Mississippi, but was not definitely identified until comparison with material at US. It is apparently most similar to material from South Carolina and North Carolina. The purpose of this paper is not to clarify the status of the varieties, but the material would therefore be referable to var. *pusillum*. The later collection of flowering material further confirmed the identity of this plant with *T. pusillum*.

The habitat in which *Trillium pusillum* was collected by us is a rich alluvial floodplain dissected by several small creeks which empty into Bouge Homa Lake. Inundation occurs probably at least once a year. The first time we collected this species, it was necessary to wade through floodwater to get to the area. The second collection (in flower) was made only one day after the entire bottomland had been flooded.

The bottomland forest where *Trillium pusillum* was collected has been disturbed by selective logging, but is still reasonably well-shaded by uncut hardwoods. Dominent species are *Pinus glabra* Walt., *Fagus grandifolia* Ehrh. and *Magnolia grandiflora* L. associated with many other hardwood species such as *Ulmus americana* L., *Fraxinus caroliniana* Miller, *Caprinus caroliniana* Walt., *Quercus lyrata* Walt., *Q. michauxii* Nutt. and *Q. nigra* L. Associated herbaceous species include *Samolus parviflorus* Raf., *Sisyrinchium angustifolium* Miller and various species of *Viola, Carex, Panicum* and *Polygala*.

There is a combination of factors which may have been responsible for *Trillium pusillum* having been overlooked in Mississippi and possibly other areas before now. First, it flowers very early in the spring, in fact is one of the earliest plants of the area. Also in some years the plant may be nearly inaccessible due to flooding. Certainly the habitat is not unique and sites similar to that where *T. pusillum* was collected by us are scattered across the southern portions of Mississippi, Alabama, and Georgia.

Specific data for the collections mentioned above are given below.

MISSISSIPPI. Jones Co.: 7 mi ENE Laurel, disturbed beech-magnolia-spruce pine woods, wet ground near logging road, 9 May 1978, *Morgan & McDaniel 468* (IBE, MISSA, duplicates to be distributed), 7 Mar 1979, *Morgan 1589* (IBE, MISSA, duplicates to be distributed).—*David Morgan and Sidney McDaniel, Dept. Biological Sciences, Mississippi State University and Institute for Botanical Exploration, Box EN, Mississippi State, MS 39762.*

REFERENCE

ROE, G. F. 1978. Additions to the Range of *Trillium pusillum*. Castanea 4: 191–195.

RANGE EXTENSIONS OF *BRAZORIA PULCHERRIMA* LUNDELL (LAMIACEAE).—*Brazoria pulcherrima* Lundell is now known from four counties growing in disturbed loose white sand as a pioneer species. In addition to collections from Leon County, collections from the other three counties are (SMU): Freestone County—*Mahler 8552*; Anderson County—*Mahler 8553*; Houston County—*Mahler 8545.*

This taxon was one of the proposed taxa for the Federal List of Endangered Species (*Federal Register* 41 (117): 24549. 1976) since it was known only from a local area. Funds for this field study were provided by the office of Endangered Species, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

The range of distribution of the species has not been greatly increased but its role as an invader species of recently distributed loose white sands enables the taxon to apparently co-exist with man and his activities even though it is a rare endemic to Texas.—*Wm. F. Mahler, SMU Herbarium, Dallas, TX 75275.*

RUBUS TRIVIALIS MICHX. VAR. **DUPLARIS** (SHINNERS) MAHLER, COMB. NOV. (ROSACEAE).—Based on *Rubus duplaris* Shinners, Field & Lab. 22: 27. 1954. Holotype: Freestone County, 13.6 mi S of Fairfield, 2 May 1953, *Shinners 14465* (SMU!).

Rubus duplaris Shinners was one of the proposed taxa for the Federal List of Endangered Species (*Federal Register* 41(117): 24562. 1976) since it was known from only two locations (counties) in Texas at that time. Subsequent field work has resulted in expanding the known distribution of this taxon and observations of the variability of the amount and type of pubescence warrant the recognition of this taxon at the varietal level.

This variety commonly grows in the deeper sands (Carrizo) of the oak-hickory (oak-pine—Bastrop County), and possesses abundant soft hairs and red, glandular hairs on the upper and lower leaflet surfaces of both primocanes and floricanes. In adjacent areas of shallower sands and sandy loam soils, the amount and type of pubescence varies on the primocane and floricane leaflets. The specimens from Angelina County are intermediate and possess few red, glandular hairs on the leaflet surfaces. In some locations, *Rubus trivialis* var. *trivialis* and var. *duplaris* grow together with varying amounts of abundance and type of pubescence on the leaflets of the primocanes and floricanes on the same plant.

The Rare Plant Study Center of the University of Texas reported that TEX did not have any collections of *Rubus duplaris* (A preliminary survey of the distribution of proposed endangered Texas plants (FR 6/16/76). 1977. U.S. FWS).

The range of the distribution of this variety is given in Figure 1 and documentation includes more than thirty specimens (SMU) collected by

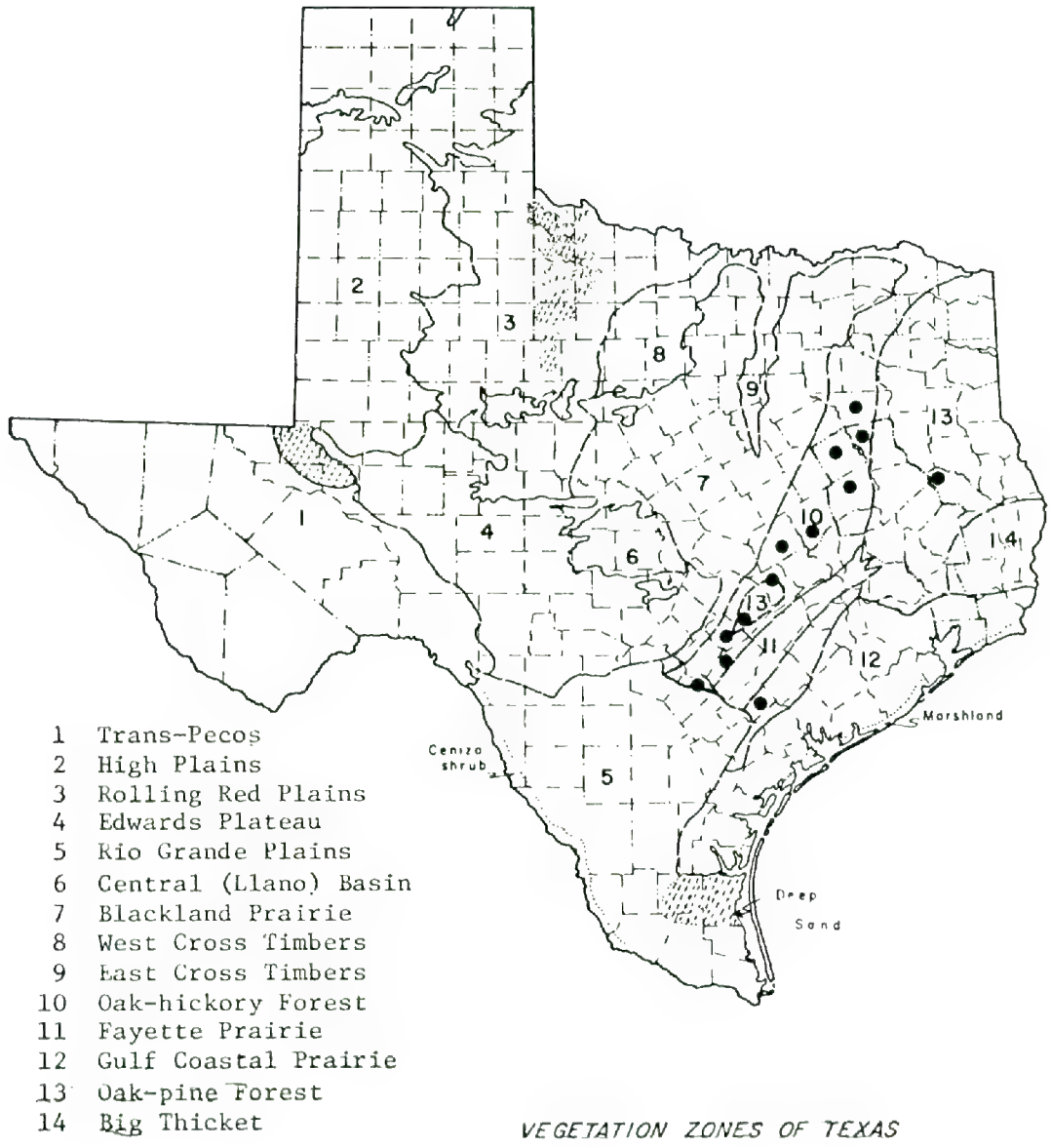

Fig. 1. Documented distribution of *Rubus trivialis* Michx. var. *duplaris* (Shinners) Mahler.

Shinners, Kral, Cory, McVaugh, Lipscomb, and Mahler. The vegetation zones in Figure 1 are a compilation of past researchers.

I am indebted to Barney Lipscomb and Larry Lodwick for their assistance and to the office of Endangered Species, U. S. Fish and Wildlife Service, Albuquerque, New Mexico for providing travel funds.—*Wm. F. Mahler, SMU Herbarium, Dallas, TX 75275.*

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A NOTE ON THE DISTRIBUTION OF *STYRAX AMERICANA* (STYRACACEAE) IN TENNESSEE.—The range of *Styrax americana* Lam. var. *americana*, the American Snowbell, is primarily confined to the Atlantic and Gulf Coastal Plain, Piedmont, and Mississippian Embayment as indicated by the distribution map of Gonsoulin (Sida 5: 191–258, 1974). The rarity of this taxon in the Interior Low Plateau in general and the apparent absence of it from this Province in Tennessee or from other provinces eastward in Tennessee is striking. This absence was also noted by Shanks in his lists of Tennessee woody plants (Journ. Tenn. Acad. Sci. 27: 27–50, 1952, 28: 1958–1959, 1953; Castanea 17: 90–96, 1952). In fact, Shanks included it as an indicator species of the lowland forests of the Mississippian Embayment in western Tennessee (Journ. Tenn. Acad. Sci. 33: 195–210, 1958). However, recent collections from Stewart County (*Schibig, 514*, APSU, VSCC; *Chester 3288*, APSU) definitely adds this species to the ILP Province in Tennessee.

Another fact of significance is that the Hamilton County collection cited in the Gonsoulin text is not indicated on the distribution map; hence the addition of this species to the eastern Tennessee flora may be overlooked if only the map is consulted.—*Joe Schibig, Volunteer State Community College, Gallatin, TN 37066 and Edward W. Chester, Austin Peay State University, Clarksville, TN 37040.*

NOTES ON PLANTS OF MISSISSIPPI II. ADDITIONS TO THE FERN AND FLOWERING PLANT FLORA—In the course of field work on the flora of Mississippi, in 1978–79, I have found some ferns and flowering plants which appear not to have been previously collected in Mississippi. None of the species of ferns reported here were included in the most recent treatment of pteridophytes of Mississippi, Evans (SIDA 7(3): 282–297. 1978).

Herbarium specimens are in the University of Tennessee, Vanderbilt University, and Museum of Natural Science (Jackson).

PTERIDOPHYTA

Asplenium resiliens Kunze

Tishomingo County: Pickwick Lake: Wooded bluffs between Eastport Beach and entrance to Yellow Creek. Crevices of shale. Rare. 4–5 Oct 1978, *Rogers 46125, 46195.*

Athyrium thelypteroides Desv.

Hinds County: About 4.0 mi N of Edwards from I-20: Mesic woods in ravines in Loess Hills region. Rare. 20 Oct 1978, *Rogers 46264.* Tishomingo County: Yellow Creek peninsula, cove N of Cooks Landing. Rare in mesic woods, 19 May 1979, *Rogers 46710.*

Cheilanthes alabamensis Kunze

Wilkinson County: Clark Creek natural area: dry border of mixed woods on a road cut. Rare. 7 Aug 1978, *Rogers 45417.*

Cyrtomium falcatum Presl

Adams County: About 10 mi NW of Natchez just N of Hwy 555, T8N, R2W, Sect 27; wooded ravines in Loess Hills region. Frequent locally. 10 May 1978, *Rogers 45178.*

Adams County: Loess Hills just N of Quitman Road at the delta, T8N, R3W, Sect. Several plants growing on steep ravine slopes. 16 Aug 1978, *Rogers 45546.*

Adams County: Loess Hills just N of Hwy 552, about 3 mi W of Mt Zion Church, T12N, R13E, Sect 32. Several plants on ravine slopes. 16 Aug 1978, *Rogers 45544.*

Pellaea astropurpurea Link

Tishomingo County: Yellow Creek peninsula, T1S, R16W, Sects 24 and 30; in second-growth hardwood-pine on calcareous shale bluffs. Rare 5 Oct 1978, *Rogers 45544.*

Selaginella uncinate Spring

Jefferson County: About 1/4 mi W of Alcorn State University farm and campus: ravine slopes and bottom, in full sun. A single large population seen, numbering several hundred individuals. Rare and local. 5 Apr 1978, *Rogers 45062.*

SPERMATOPHYTA

Carex grayii Carey

Tishomingo County: Yellow Creek Quad, T1S, R11E, Sect 30, first cove N of Whetstone Branch. Rare and local in rich mesic woods, 15 May 1979, *Rogers 46640.*

Dicentra cucullaria (L.) Bernh.

Tishomingo County: Yellow Creek Quad, T1S, R10E and R11E, Sects 24, 25, and 30. Rare and local in rich woods and on shale bluffs. 10 Apr. 1979, *Rogers 46443.*

Hydrophyllum appendiculatum Michx.

Tishomingo County: Yellow Creek peninsula, T1S, R11E, Sect 30; first cove north of Whetstone Branch. Rare in moist cherty deciduous woods. 15 May 1979, *Rogers 46638.*

Hydrophyllum macrophyllum Nutt.

Tishomingo County: Yellow Creek peninsula, T1S, R11E, Sect 30; first cove N of Whetstone Branch. Rare in moist rocky deciduous woods. 15 May 1979. *Rogers 46637.*

Kochia scoparia (L.) Roth

Hinds County: Jackson: along railroad tracks W of Travelodge Motel at Amite and Adams streets. 9 May 1979, *Rogers 46621.*

Phacelia bipinnatifida Michx.

Tishomingo County: Yellow Creek Quad, T1S, R10E and R11E, Sects 24, 25, 30. Rare in rich mesic woods and wooded shale bluffs. 10 Apr 1979, *Rogers 46442.*

Philadelphus hirsutus Nutt.

Tishomingo County: Yellow Creek Quad, T1S, R10E, Sect 14. Very rare on calcareous shale bluffs, in pine-oak woods. 15 May 1979, *Rogers 46628.*

Scutellaria ovata var. *versicolor* (Nutt.) Fern.

Tishomingo County: Yellow Creek peninsula, T1S, R11E, Sect 30. First cove N of Whetstone Branch. Rare in rocky, mesic deciduous woods. 15 May 1979, *Rogers 46643.*

Taenidia integerrima (L.) Drude

Tishomingo County: Yellow Creek Quad, T2S, R11E, Sect 31. Whetstone Branch; dry rocky south-facing slopes; several plants occurring locally. 11 Apr 1979, *Rogers 46503.*

Tradescantia ernestiana Anders. and Woodson

Tishomingo County: Yellow Creek Quad, T1S, R11E, Sect 30; Boo Hollow. Rare in mesic woods. 15 May 1979, *Rogers 46650.*

Trautvetteria caroliniensis (Walt.) Vail

Tishomingo County: Yellow Creek Quad, T2S, R11E, Sect 6. Very rare and localized along Short Creek, on calcareous shale, in seepage areas E of road leading to Cooks Landing. 9 Apr 1979, *Rogers 46502.*

Viola pensylvanica Michx.

Tishomingo County: Yellow Creek Quad, T1S, R10E, Sect 24; Meat Hollow. Several plants locally in cherty moist deciduous woods. 14 May 1979, *Rogers 46629.—Ken Rogers, Mississippi Museum of Natural Science, 111 North Jefferson Street, Jackson, MS 39202.*

NEVIUSIA ALABAMENSIS (ROSACEAE) IN MISSISSIPPI—*Neviusia alabamensis* A. Gray, commonly known as Snow Wreath, is a low shrub in the Rose Family. It has been known previously from Tuscaloosa County in Alabama, Conway County, Arkansas, and Butler County, Missouri (Clark, 1971; Small, 1933; Steyermark, 1963).

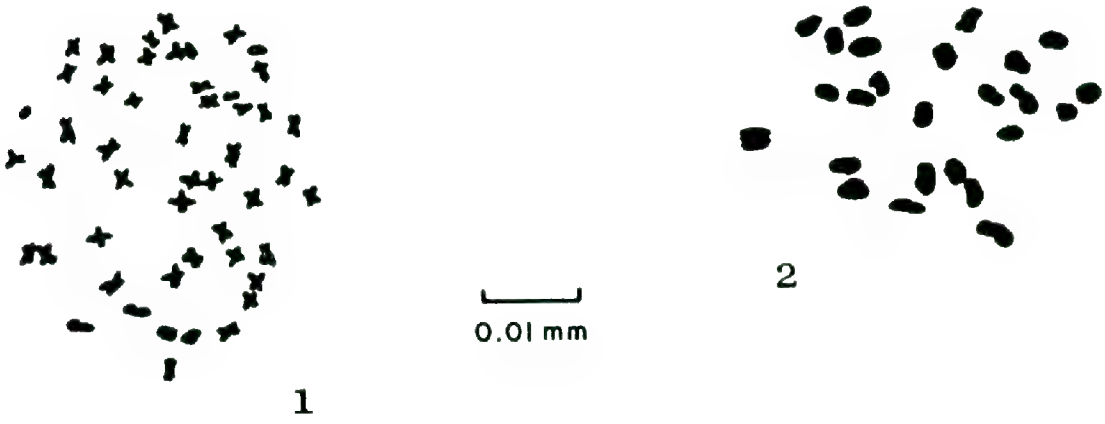
In October 1978 I found a large colony of Snow Wreath, in the hilly woodland of northeast Mississippi, in Tishomingo County, growing on calcareous shale bluffs overlooking the Tennessee River and Pickwick Lake. A second colony was found in November in the same stretch of bluffs.

Sun Wreath was growing in full sun on the bluffs which lie in a narrow belt from Eastport northeast to Yellow Creek. Several species of plants found

here are either unique to the bluffs or occur rarely elsewhere in Mississippi. A few plants associated with Snow Wreath were *Dodecatheon meadia, Pellaea atropurpurea, Woodsia obtusa, Solidago sphacelata, Heuchera villosa* var. *macrorhiza, Delphinium tricorne, Cladrastis lutea, Euonymus atropurpureus, Fraxinus quadrangulata, Quercus muhlenbergii, Quercus prinus, Aesculus glabra.*

Herbarium specimens (*Rogers 46149, 46652, 46670*) are in The University of Tennessee, Vanderbilt University, and Museum of Natural Science (Jackson).—*Ken Rogers, Mississippi Museum of Natural Science, 111 North Jefferson Street, Jackson, MS 39202.*

THE CHROMOSOMES OF *COLLINSONIA CANADENSIS* L. (LABIATAE).—The following preparations represent the first published illustrations of the chromosomes of *Collinsonia*, a genus of mints confined to eastern North America. The mitotic chromosomes ($2n = 50$) are shown in Figure 1 and the meiotic chromosomes ($n = 25$) in Figure 2—all derived from *Collinsonia canadensis* L. (PA, Centre Co.: *C. S. Keener 1978*, PAC).—*Carl S. Keener, Department of Biology, The Pennsylvania State University, University Park, PA 16802.*



NICOLLETIA OCCIDENTALIS (COMPOSITAE) IN BAJA CALIFORNIA!—A specimen at SD (Valle de San Felipe, southeast of Santa Clara, ca. 31°03'N, 115°13'W, with *Larrea, Fouquiera, Simmondsia,* and *Cercidium* at ca. 400 m., 3 Apr 1977, *Fred Sproul s.n.*), brought to my attention by Dr. R. Moran, documents the occurrence of *Nicolletia occidentalis* in Baja California. This collection extends the known range of the species some 300 km. south to within ca. 100 km of the nearest known population of *N. trifida* (cf. my review of *Nicolletia*, Sida 7:369–374. 1978). The Parishes are not known to have collected in Lower California (cf. ibid.).—*John L. Strother, Department of Botany, University of California, Berkeley, CA, 94720.*

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Frontispiece. *Hedeoma microphyllum* Irving.

THE SYSTEMATICS OF HEDEOMA (LABIATAE)

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The genus *Hedeoma* (Labiatae) is a group of annual and perennial herbs found throughout southwestern United States and Mexico and in scattered localities in South America. In this treatment it is composed of 38 species and 5 varieties.

Hedeoma is a member of the subtribe Melissinae of the tribe Stachyoideae of Briquet (1897). Its generic boundaries have undergone widely divergent modifications during the last 170 years, as indicated by the publication of Persoon (1807), Bentham (1832-1836, and 1848), Gray, (1878), Briquet (1897), and Epling and Stewart (1939). The intent of this work, although by no means definitive, is to present a coherent delimitation of *Hedeoma* based on extensive field and experimental data.

In addition to the problems of generic limits and phyletic position of *Hedeoma*, there are numerous problems at the specific and intraspecific levels. In previous works, including the most recent inclusive treatment of the group by Epling and Stewart (1939), there was little or no attempt to explore questions of intra- and interspecific relationships or phylogeny. Such an exploration is one of the primary goals of this monograph, and it is believed that the present treatment to a great extent, places the taxa of *Hedeoma* in natural groupings not only from the standpoint of morphology, ecology, and geography but phylogeny as well.

A list of representative specimens is available on request.

HISTORICAL ACCOUNT

The genus *Hedeoma* was proposed by Persoon in 1807 to accommodate three species: *H. thymoides, H. glabrum*, and *H. pulegioides*. In Bentham's (1836) treatment of *Hedeoma, H. thymoides* and *H. glabrum* were excluded from the genus; *H. pulegioides* was retained as the type species and seven other newly described or previously unrecognized species were added. He also divided the genus into two sections, *Mosla* and *Hedeoma*. Between 1848 and the publication in 1876 of the Genera Plantarum, Bentham elevated the section *Mosla* to generic status and added four additional species to *Hedeoma* proper bringing the total to 12. Gray's treatment in 1878 resulted in a circumscription very similar to the present one. Gray recognized eight additional taxa as belonging to *Hedeoma*, and divided the genus into the sections *Euhedeoma*, which includes most of the

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currently accepted species, and *Stachydeoma*. The latter section was elevated to generic rank by Small (1903); later its two species were disaggregated into the monotypic genera *Rhododon* and *Stachydeoma* (Epling and Stewart, 1939).

In Briquet's (1897) treatment of Labiatae, *Hedeoma* was expanded to include *Keithia* Benth., *Poliomintha* Gray, and other related genera. However, Epling and Stewart (1939) returned to the earlier generic delineation of Bentham and of Gray. They believed that Bentham's account was a more natural, logical, and consistent interpretation of the relationships involved than that of Briquet, who, for lack of a single clearcut difference between these genera lumped them together.

The present treatment is essentially that of Epling and Stewart and I am in full agreement with their arguments against Briquet's expanded generic concept. My treatment differs in that three of the four North American representatives of Epling's genus *Hesperozygis* have been incorporated into *Hedeoma* and several new taxa have been added.

GENERIC LIMITS AND RELATIONSHIPS

There are 11 other genera which, on morphological grounds, are considered closely allied to *Hedeoma*. Conceivably, all of these genera, including *Hedeoma*, could be considered to constitute a single very large genus, in fact seven genera, *Mosla, Rhododon, Stachydeoma, Poliomintha, Eriothymus, Hoehnea*, and *Rhabdocaulon* have at one time or another been merged with *Hedeoma*.

The genus *Ziziphora*, of the Mediterranean region, can be considered the Old-World counterpart of *Hedeoma* as its overall habit and floral morphology are similar. In Bentham's treatment of the Labiatae (1832–1836, and 1848), *Ziziphora* was placed in the tribe Monardeae, thus suggesting considerable morphological divergence of *Hedeoma* from *Ziziphora*. Briquet (1897), on the other hand placed *Ziziphora* next to *Hedeoma* in his subtribe *Melissinae*. *Ziziphora* and *Hedeoma* can be distinguished by several morphological features. *Ziziphora* possesses a tubular calyx with connivent, subequal, narrowly triangular teeth—a feature very reminiscent of the calyces of *Poliomintha*. Further, *Ziziphora* is separated by a technical character of the anthers; unlike *Hedeoma*, the lower anther-sacs of *Ziziphora* are completely or partially aborted.

The diverse genus *Cunila*, despite an obvious morphological affinity with *Hedeoma*, has always been placed distantly from *Hedeoma* by both Bentham and Briquet. The features which distinguish the genera are subtle. The stamens of *Cunila* are seated above the middle of the corolla tube, ascend from the orifice, surpassing the upper lip. The tubular or turbinate calyx has 10–13 nerves, and is rarely more than 5–6 mm long; the teeth are subequal. It should be noted that within *Hedeoma, H. floribundum* has characteristics of the calyx similar to those found in this genus, perhaps suggesting an even

closer relationship than previously supposed.

Pogogyne is a small California genus which both Bentham and Briquet reckoned it to be a close relative of *Hedeoma*. However, careful comparison of the two genera reveals a number of striking differences. The principal features of *Pogogyne* which distinguish it from *Hedeoma* are as follows: habit, annual; inflorescence a dense terminal "spike" of cymes; calyx deeply cleft and 15-nerved; stamens 2 or 4; anther sacs parallel; style pubescent; and, chromosome number, $n = 19$ (Ornduff, 1967).

The genus *Glechon* was recognized and treated as a close relative of *Hedeoma* by Bentham (1832–36 and 1848). Briquet (1897), on the other hand, placed *Glechon* into a different subtribe. Epling and Stewart (1939) again aligned the genus with *Hedeoma*. Since the principal distinguishing feature resides in the corolla, it is not surprising that Briquet, who strongly emphasized corolla morphology in his treatment, should fail to indicate close relationship between the two genera. Briefly, *Glechon* differs from *Hedeoma* in being composed of South American fruticose herbs with sessile cymules; calyx tube 13–15-nerved, turbinate, with subequal deltoid or deltoid-subulate teeth; corolla ample, abruptly expanded, the upper lip manifestly longer than the lower; stamens genticulate at the base and hairy.

The Asiatic genus *Mosla* was originally placed in *Hedeoma*, later, as more species became known, it was separated from *Hedeoma* and given generic rank. *Mosla* differs from *Hedeoma* primarily in having a 10 rather than 13-ribbed calyx and in having a racemose inflorescence.

Rhododon ciliatus was included in *Hedeoma* sect. *Stachydeoma* and later *Stachydeoma*. In 1939 Epling and Stewart elevated it to generic rank. *Rhododon* is readily distinguished from *Hedeoma*. *Rhododon* is a coarse annual with sessile, long pilose-ciliate leaves and has a dense terminal "spike"; a 15-nerved, deeply cleft calyx; no staminodes; a pubescent style; and a chromosome number of $n = 13$.

The genera, *Hoehna, Eriothymus,* and *Rhabdocaulon* are all believed to be offshoots of the diverse genus *Keithia*. Bentham treated *Keithia* as very close to *Hedeoma*, but Briquet (1897) included the whole of *Keithia* into *Hedeoma*. Epling not only recognized *Keithia* as distinct but further divided the group into three genera, a treatment with which, after careful examination of many representatives of these groups, I am in complete accord.

Stachydeoma graveolens was included in the genus *Hedeoma* by both Gray (1878) and Briquet (1897). In 1903, Small created *Stachydeoma* as a distinct genus based on *H. graveolens* and *H. ciliatum*. Unlike *Rhododon ciliatus,* with which it was previously grouped, *Stachydeoma* cannot be kept easily as a distinct genus. It is very *Hedeoma*-like in the details of the calyx and corolla and in the important features of the nutlets. The separating features reside in the pilose, sessile leaves and in its chromosome number, $n = 9$.

Poliomintha and *Hesperozygis* are also allied very closely to *Hedeoma*. As the differences are more quantitative than qualitative, the genera are con-

trasted with *Hedeoma* in the tabular form below.

Hedeoma	*Poliomintha*
Occasionally semishrubs, usually herbaceous perennials or annuals.	Shrubs.
Calyx tube gibbous or saccate.	Calyx tubular and symmetrical.
Calyx teeth usually acuminate and well differentiated into upper and lower sets.	Calyx teeth subsequal, convergent to close the orifice.
Calyx annulus in a well-defined ring.	Calyx annulus absent or in an irregular ring.
Nutlets oblong or orbicular in outline, ca. 1.5 mm long or less, usually becoming mucilaginous when moistened.	Nutlets oblong, over 1.5 mm long, not becoming mucilaginois when moistened.
$2n = 34, 36, 44, 72, 144$.	$2n = 36$.

Hedeoma	*Hesperozygis*
Primarily N. American	Primarily S. American
Semi-shrubs, or more commonly perennials or annual herbs, leaves various but not leathery.	Shrubs with leathery leaves.
Calyx 13-nerved.	Calyx 13–16 nerved.
Calyx tube various but not funnelform.	Calyx tube funnelform.
Calyx teeth various.	Calyx teeth subequal, deltoid lanceolate, erect and parallel.
Calyx annulus seated at or near the juncture of the upper and lower teeth at the tube's summit.	Calyx annulus usually seated near the middle of the tube.
$2n = 34, 36, 44, 72, 144$.	$2n = 44$.

The genus *Hesperozygis* in both its original circumscription (Epling, 1936; Epling and Stewart, 1939) and in subsequent additions (Epling, 1940) houses a bewildering array of seemingly unrelated taxa. It is rendered somewhat more homogeneous by removing to *Hedeoma* three of its former species, but the remaining species are problematical still and are likely to remain so until a more comprehensive study is undertaken.

All of the above-cited genera are closely interrelated. Though they all have two stamens, they are probably related to the four-stamen groups through the genera *Satureja* and *Melissa*. Indeed, Bentham (1832–36) stated that, "*Hedeoma* scarcely differs from *Micromeria* except in the abortion of the upper stamina."

CHROMOSOMAL STUDIES

Chromosome numbers for *Hedeoma* and related genera are reported elsewhere (Irving, 1976). In summary, $2n = 36$ was the most frequently en-

countered number occuring in 67% of the taxa reported. Section *Alpine* was consistently $2n = 44$. Aneuploidy ($2n = 34$) occurred in several taxa distributed along the eastern edge of the generic range: a cluster of populations of *H. drummondii* in east-central Texas, *H. hispidum, H. acinoides* and both varieties of *H. reverchonii.* Polyploidy was found in the southernmost populations of *H. costatum* ($2n = 72$) and in *H. multiflorum* ($2n = 72$) and *H. apiculatum* ($2n = 144$). *Poliomintha longiflora* was $2n = 36$; *Hesperozygis marifolia*, $2n = 44$; *Rhododon ciliatus*, $2n = 26$ and *Stachydeoma graveolens*, $2n = 18$. Based on an analysis of the distribution of chromosome numbers and the count of *S. graveolens*, the genus *Hedeoma* is judged to be dibasic $x = 9, 11$.

BREEDING HABITS

Inbreeding, in a variety of forms, is found in all species of *Hedeoma.* The lower fertile pair of anthers, typically unseparated, dehisce and the style, which lies behind the anthers, recurves sharply at its tip into the exposed pollen mass. The time between the dehiscence of the anthers and the recurvation of the style, however, provides reproductive variability among the species.

A few of the annual species (*H. hispidum, H. medium* and *H. pulegioides*) are primarily cleistogamous and only occasionally are chasmogamous plants encountered. In the small to medium flowered species, which are the majority of *Hedeoma* species, the flowers open and the dehiscence of the anthers and the recurvation of the style occur almost simultaneously. A few of these species (*H. acinoides, H. nanum,* and *H. costatum*) can be cleistogamous. The remainder are chasmogamous inbreeders and their populations are often subtly and consistantly distinct from one another. *Hedeoma drummondii, H. costatum, H. nanum* are good examples of this phenomenon.

Among the larger flowered species (*H. hyssopifolium, H. pulcherrimum,* and *H. ciliolatum*) the opening of the flower and the maturation of the anthers and style are separated by periods of time. The anthers open approximately 12–24 hours after anthesis and the style requires 24–48 hours, after anthesis, to recurve into the exposed pollen. Insects (bees, moths and butterflies) are commonly observed visiting the large flowered species and presumably outbreeding is the predominant mode of reproduction. Occasionally through a special mechanism some plants of the largest flowered species, such as *H. ciliolatum*, are obligate outbreeders. Following anthesis in these plants, the anther pair separates and is no longer in the path of the recurving style.

In general the mode of reproduction has determined in large part my thinking as to the evolutionary development of the genus, and is well correlated with other plyletic characteristics. Large flowers and outbreeding are considered primitive traits and are typically associated with the long-lived perennial or semi-shrub habits and very restricted and non-weedy distribu-

tion patterns. Small flowers and inbreeding are believed to be derived characteristics and most commonly occur in weedy, widely distributed annuals and short-lived perennials.

NATURAL INTERSPECIFIC HYBRIDIZATION

From both herbarium and field studies there is evidence of interspecific hybridization involving at least seven species in the genus *Hedeoma*. The putative hybrids have been documented both morphologically and through the use of secondary plant constituents (Irving, unpublished ms.).

H. DRUMMONDII var. DRUMMONDII × H. NANUM var. NANUM

Both *H. drummondii* var. *drummondii* and *H. nanum* var. *nanum* occur in pure form in the mountains of southern Nevada and adjacent California, and for each this area represents the extreme western range of their distribution. Usually, these two taxa are quite distinct, but numerous specimen (cited below), although determined as *H. nanum*, are actually intermediate between *H.d.* var. *drummondii* and *H.n.* var. *nanum*. Acceptance of their hybrid status follows directly from a chromatographic survey of the specimens cited which revealed both chromotographically distinct parents and a summation of phenolic patterns for the intermediates (Irving, unpublished ms.).

Representative putative hybrids:

CALIFORNIA: San Bernardino Co.: Keystone Canyon, 14 May 1940, *Alexander & Kellogg 1483* (DS, GH). NEVADA: Clark Co.: Lee Canyon, 22 Jul 1939, *Clokey 8476* (UC). Clark Co.: Harris Spgs. Rd. 10 Jun 1940, *Clokey 8633* (NY). Clark Co.: Kyle Canyon, 14 Jun 1939, *Clokey 8478* (DS, F, GH, IA, MICH, NY, PAS, POM, US). Clark Co.: Deadman Canyon, 30 May 1940, *Alexander & Kellogg 1614* (DS, GH). TEXAS: Val Varde Co.: junction of rts 90 and 277, 4 Jun 1967, *Irving 759* (TEX).

H. DRUMMONDII var. DRUMMONDII × H. PULCHERRIMUM

These two closely related species occur in sympatric populations in the mountains of southern New Mexico around Cloudcroft. A visit to one such population 20 miles northeast of Tularosa revealed the presence of numerous intermediate plants. The latter were assumed to be hybrids since paper chromatography displayed an additive pattern for these intermediates and counts of pollen stainability revealed ca 20% stainable pollen. Both parental species consistently displayed 100% stainable pollen (Irving, unpublished ms.).

NEW MEXICO: Otero Co.: 20 mi ne of Tularosa, 5 Aug 1967, *Irving 835 a & b* (TEX).

H. DENTATUM × H. HYSSOPIFOLIUM

The occurrence of these hybrids were detected solely from morphological analysis of herbarium specimens deposited at LA. The hybrids are similar to *H. hyssopifolium* but possess reduced gibbous calyces and dentate-entire leaves

(the calyces of *H. hyssopifolium* are usually large and nongibbous and the leaves entire).

Representative hybrid specimens:
ARIZONA: Cochise Co., Huachuca Mts, 5 Sep 1936, *C. Epling* and *W. Stewart* s.n. (LA) (2 sheets).

H. DRUMMONDII × H. REVERCHONII var. REVERCHONII × H. R. var. SERPYLLIFOLIUM

Each of these taxa come together on the arid limestone outcroppings of the Edwards Plateau of Central Texas. Here all three form large sympatric populations on the same chromosome level ($2n = 34$). Although inbreeding and microhabitat differences work to maintain the integrity of each taxon, hybridization in all possible combinations occurs and much of the inter- and intra-populational variation appears to be the result of past and present gene exchange. Gas chromatography, morphology, and pollen fertility were employed in the detection of hybrids (Irving and Adams, 1973).

SPECIFIC CONCEPTS

The taxa of *Hedeoma* are delimited by combined information taken from morphology, cytology, ecology, and geography. I have tried to be consistent in my recognition of species, subspecies, and varieties; that is, I have attempted to accord formal names to comparable categories. In several cases, as in *H. palmeri* and *H. acinoides*, various intraspecific races have been acknowledged but were not accorded formal taxonomic recognition. In regard to the species concept itself, I shall refer to discussions presented by Raven (1962) and Lewis and Lewis (1955). The species concept presented in these papers most accurately reflects my own beliefs.

With the categories subspecies and variety, the term "variety" is reserved for divergent subspecific populational units which display genetic and geographic integrity. The term subspecies is used as a grouping category for closely allied varieties, much as the subgenus is used to group closely allied sections. This usage is as interpreted by Turner (1965), and Kapadia (1964).

ECOLOGY, DISTRIBUTION, AND POSSIBLE ORIGIN

As a prelude to a discussion on the ecology, distribution, and possible origin of the species in *Hedeoma*, I would like to cite what I consider to be primitive and derived characters for the genus (Table 1). In an effort to present a phyletic picture, I have adopted the "Wagner Divergence Index" (Fig. 1) as developed by W. H. Wagner, Jr., and illustrated by Hardin (1957). To derive a divergence index for a given species the characters were ranked 0, 1, or 2, depending on their assumed primitive, intermediate or derived condition, respectively. A numerical total, which might be termed a phyletic index, is obtained by summing the value for each of these char-

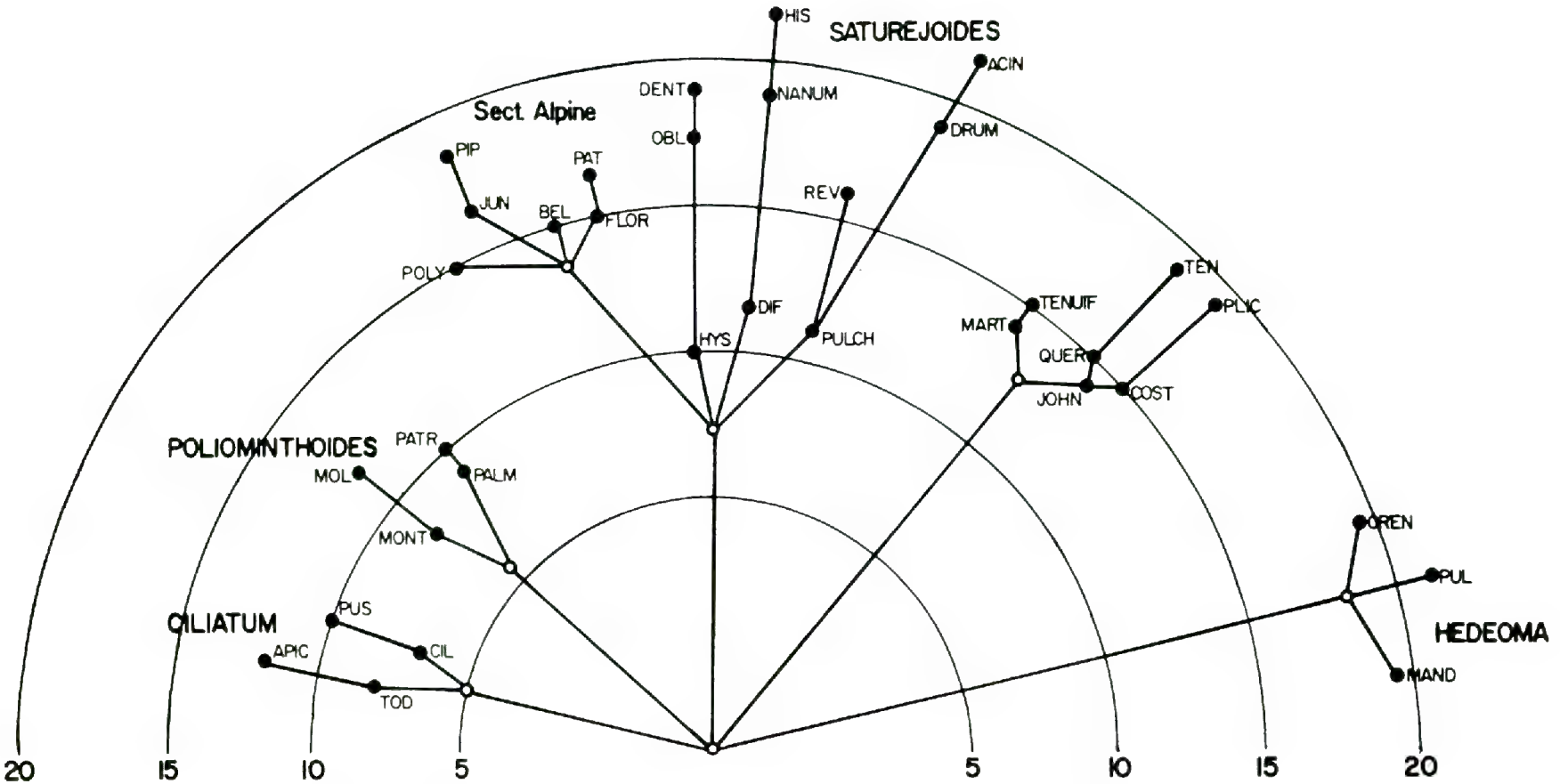


Fig. 1. Divergence in the genus *Hedeoma*. Concentric arcs represent levels of specialization. Open circles suggest hypothetical ancestors; and solid circles are extant taxa (see text).

acter states for any given taxon. The phyletic indices are then plotted upon concentric circles and arranged so as to form a phyletic "tree" or dendrogram (Fig. 1).

In these calculations there have been no weighting of characters; for example, the characters of the leaf margin carry as much weight as characters relating to corolla size. In many cases "intermediate" states were not found; consequently they are not listed in the tabulation.

From Table 1, the primitive *Hedeoma* would be an entire-leaved shrub with simple pubescence and solitary flowers; the calyx tube would be radially symmetrical with erect, united teeth and no annulus; the corolla would be large with a flat upper lip and possessing a definite annulus; nutlets would be brown, oblong, not becoming mucilaginous when moistened; and there would be 36 large, symmetrical chromosomes. No single taxon has all of the criteria for one state or the other, although several approach the purely primitive or derived condition. In particular, three species emerge as primitive for the genus: H. *ciliolatum, H .todsenii* and *H. palmeri* (phyletic indexes 7, 8, and 8, respectively; Fig. 1). At the other end of the spectrum the annual, *H. hispidum*, is the most advanced, possessing 13 of the criteria for the derived condition (phyletic index 24); it is closely followed by *H. acinoides* (phyletic index 23).

TABLE 1.

PRIMITIVE AND DERIVED CHARACTERS

PRIMITIVE (0)	INTERMEDIATES (1)	DERIVED (2)
1. Shrubby or suffrutescent	Herbaceous perennials	Annuals
2. Leaves entire	Intermediate	Variously toothed
3. Hairs simple, plants relatively glabrous	Hairs simple; plts pubescent	Hairs branched
4. Flowers solitary	Cymules 3–5 flowered	Cymules 5 or more flowered
5. Calyx tube radially symmetrical or nearly so	Tube gibbous or sigmoid	Tube saccate
6. Calyx teeth erect and only slightly differentiated into upper and lower sets	Intermediate	Teeth variously reflexed and well differentiated into upper and lower sets
7. Upper calyx teeth scarcely united	Teeth united for less than $\frac{1}{2}$ their length	Teeth united over $\frac{1}{2}$ their length
8. Calyx annulus absent	A broken or undulating ring	A definite ring
9. Corolla large (over 12 mm) and with an expanded throat	Less than 12 mm or long tubular	Minute and barely exserted from the calyx

10. Delayed autogamous/ allogamous in breeding habit	Intermediate	Autogamous and/or cleistogamous
11. Nutlets not becoming mucilaginous when moistened		Mucilaginous when moistened
12. Nutlets oblong in outline		Orbicular in outline
13. Chromosome number $2n = 36, 44$		$2n = 34, 72$, or 144
14. Chromosome large and symmetrical		Small and asymmetrical
15. Plants of mesic, montane habitats	Intermediate	Open-arid habitats

The genus *Hedeoma* is divided into 4 subgenera and it is my impression that each developed early in the evolution of the genus and subsequently each followed its own evolutionary course. *Ciliatum* and *Poliominthoides* are believed to be the oldest of the sub-generic lines, with *Saturejoides* and *Hedeoma* occupying the intermediate and youngest positions, respectively. No firm evidence is available with which to determine the time of divergence of these phylads, but it is suggested that prototypes for these subgenera developed out of the Madro-Tertiary Geoflora during the Oligocene, or perhaps earlier. As the extant species of *Hedeoma* are associated with both the Madro-tertiary and Arcto-tertiary floras, the ancestral stocks may have developed in the ecotonal region between these two floras (Axelrod, 1950).

The subgenus *Ciliatum* is composed of five narrowly endemic species which are spatially and morphologically well-separated. This fact, along with their large number of primitive traits, speaks for a rather lengthy evolutionary history for the group. The species are confined to relict communities of the Sierra Madrean woodland of the dissected Madro-Tertiary flora (Axelrod, 1958). *Hedeoma ciliolatum* and *H. todsenii* are the most primitive, occuring in mesic pine forests near Galeana, Nuevo Leon, Mexico and the forest communities of the San Andres Mountains of New Mexico respectively. *H. apiculatum* and *H. pilosum*, are more advanced species occurring in the open, more xeric rock crevices in the mountains of Trans-Pecos Texas.

The subgenus *Poliominthoides*, is believed to have had an evolutionary pattern similar to that of *Ciliatum*. Its four taxa, while also very distinct morphologically, are much wider ranging. To the north, *H. patrinum, H. montanum*, and *H. molle* are associated with the drier elements of the Sierra-Madrean woodland and to the south *H. palmeri*, occurs principally in the pine-oak woodlands of the Sierra Madre Oriental.

The subgenus *Saturejoides* can be divided into two geographical and morphological groups: (1) section *Alpine* in which the members are all

montane species of the Sierra Madre Occidental; and (2) section *Saturejoides*, the species of which occupy a wide variety of habitats.

The ecology and distribution of section *Alpine* suggest a strong affinity with the Arcto-Tertiary Geoflora and the section may well have had its origin within it. The pine forests in which the species of *Alpine* now occur are believed to be extensions of the Arcto-Tertiary flora which extended southward with the uplifting of the Rocky Mountain chain. The lack of transitions with other species and the disjunctive distribution pattern of its species suggest that the former ranges of species belonging to this section may have been contracted with the spread of aridity during late Tertiary times.

Section *Saturejoides* is composed of taxa of varying habits and habitats and can be considered the core of the genus. Xerophytic annuals and perennials dominate the section and, for the most part, the North American taxa can be aggregated into four species complexes: 1) *H. costatum-plicatum-tenuipes-microphyllum,* 2) *H. nanum-diffusum,* 3) *H. oblongifolium-dentatum-hyssopifolium,* and 4) *H. drummondii-reverchonii-pulcherrimum.* These complexes typically have wide distribution patterns and display combinations of relatively specialized morphological attributes. Each complex includes a less specialized and distributionally restricted montane species, *H. costatum, H. diffusum, H. hyssopifolium,* and *H. pulcherrimum* respectively. The xerophytes presumably evolved with the expansion of arid areas and dissection of the Madro-Tertiary Geoflora.

The subgenus *Hedeoma* has been the most difficult with which to contend in terms of origin and phylogeny. It seems to be a recent line, on morphological grounds, but its connection with the other subgenera of *Hedeoma* is obscure. Further, the species are well separated and do not merge one into the other as might be expected in a youthful phylad.

SYSTEMATIC TREATMENT

HEDEOMA Pers., Syn. Pl. 131, 1807

Annuals or caespitose, suffrutescent, or herbaceous perennials, forming semi-shrubs, tufts, clumps, or mats. Shoots solitary to numerous, strict, ascending, or decumbent and often producing adventitious roots from the lower nodes; shoots variously branched; arising from a slender or thickened taproot, woody caudex, or trailing rootstock; variously pubescent with hairs simple and spreading or retrorsely curving (tomentose, in *H. molle* with hairs profusely branched). Leaf pairs crowded or well-spaced. Leaves membranous or coriaceous; ascending, spreading, or cernuous; oval, ovate, elliptical, oblong, lanceolate, linear or spatulate; entire, crenate, serrate, or dentate (often obscurely so); apex obtuse or acute; base sessile, subsessile, or petiolate; blades tomentose (*H. molle*), canescent (subgenus *Poliominthoides*), or variously pubescent with ciliate margins; nervation indistinct to conspicuous with the nerves forming raised costae on the undersurfaces (*H. plicatum, H. pusillum,* and *H. ciliolatum*), the leaf surfaces smooth, glandular-

dotted, or glandular-punctate to varying degrees. Flowers solitary or disposed in axillary cymes (cymules) 1–31 flowered, well-spaced along the axis or aggregated into a terminal "spike" of cymes; peduncles inconspicuous to several millimeters long; pedicels conspicuous, usually several millimeters long and variously pubescent with spreading or retrorsely curving hairs; bracteoles typically subulate or lanceolate, either shorter or longer than the pedicels they subtend. Calyx 3.0–15.0 mm long, highly zygomorphic to nearly actinomorphic (subgenus *Poliominthoides*); tubular, tubular-sigmoid, or tubular-funnelform; usually gibbous or saccate below for ¼ to over ¾ of the tube's length, variously pubescent and usually with the pubescence diminishing in size and density toward the teeth apices (evenly tomentose in *H. palmeri* and *H. molle*); the calyx teeth markedly or scarcely (subgenus *Poliominthoides*) differentiated into upper and lower sets; the three upper teeth variously connate forming an upper lip; the connate portion of the lip either short or expanded, and either glabrous or pubescent on its inner face; the lobes semi-ovate, deltoid, narrowly triangular or subulate, glabrous or hirtellous to hirsute-ciliate, laterally spreading or erect and convergent (*H. multiflorum, H. drummondii*); the two lower teeth generally not coalesced, narrowly triangular or subulate, and typically recurved and surpassing the length of the upper lip (short, equal to the upper lip in the subgenus *Hedeoma*), ciliate, or, occasionally glabrous on the margins; calyx with a well-defined ring of simple hairs (the annulus) within which tend to be projected outwardly and partially seal the calyx orifice, occasionally upwardly extended onto the inner face of the upper lip (*H. piperitum, H. medium,* and *H. multiflorum*), 0.5–1.5 mm. wide and seated at the juncture of the upper and lower teeth or below it, included or exserted from the calyx tube. Corolla white, blue, lavender, pink, or orange-red, extremely variable, 3.0–45.0 mm long, always zygomorphic with the limbs forming upper and lower lips, glabrous or pubescent within in two decurrent lines along an abaxial groove or channel running along the throat floor or simply pubescent in the throat, also commonly pubescent within the tube, occasionally the hairs forming a well-defined annulus; the tube gradually or abruptly expanded upwardly; the upper lip obcordate to ligulate, concave and subgaleate or flat, straight or reflexed away from the axis, scarcely to deeply emarginate; the lower lip spreading to erect (subgenus *Hedeoma*), equally three lobed or more commonly with the central lobe exserted beyond the laterals and bilobed. The abaxial stamen pair arising from the middle of the corolla (upper ¼ in. *H. martirense*) and ascending upwardly under the upper corolla lip or surpassing it, the anther sacs nearly parallel to widely divaricate on well-developed connectives; the adaxial pair reduced to staminodia, 1.0–2.0 mm long, arising opposite the fertile pair on the adaxial surface, occasionally the staminodia bear abortive anther sacs at their apices (*H. pulegiodes*). Style long and bifid at the apex with the abaxial segment markedly longer than the adaxial one, glabrous. Nutlets orbicular, ovate, or

oblong in outline, ovate or ovate-triangular in cross section, brown or black at maturity, the surface areolate, foveate, or ruminate, weakly to strongly glaucous, usually mucilaginous when moistened. Chromosome numbers, $2n = 34, 36, 44, 72$, or 144 ($x = 9, 11$).

Type species: *Hedeoma pulegioides* (L.) Pers.

Distribution: North and South America. Centers of distribution appear to be in the mountains of far northwestern Mexico, and the mountains of southern Arizona and New Mexico; also in the Sierra Madre Oriental of east central Mexico.

KEY TO THE SUBGENERA OF *Hedeoma*

1. Plants caespitose, often forming dense mats, 4.0–12.0 cm high; leaves coriaceous, entire and sessile; flowers solitary or in three-flowered axillary cymules; corolla large and showy, 10.0–32.0 mm long; western Texas, New Mexico and northern Mexico ..... I. Subgenus CILIATUM
1. Plant loose, herbaceous annuals or perennials or semi-shrubs; leaves various; flowers in three or usually more flowered axillary cymules; corolla 3.0–45.0 mm long, plants variously distributed.
   2. Suffrutescent, canescent perennials, usually semi-shrubs, 15.0–100.0 cm tall; leaves canescent; axillary cymules commonly but not always aggregated into terminal "spikes"; calyces tubular, nearly radically symmetrical with the teeth only slightly differentiated into upper and lower sets. ..... II. Subgenus POLIMINTHOIDES
   2. Plants usually herbaceous annuals or perennials; leaves variously pubescent but never canescent; calyces bilaterally symmetrical with the teeth markedly differentiated into upper and lower sets.
      3. Leaves and calyces various; lower calyx teeth usually longer than upper; nutlets brown to dark brown at maturity, commonly glaucous, oblong or occasionally obicular in outline, mucilaginous when moistened, plants variously distributed. ..... III. Subgenus SATUREJOIDES
      3. Leaves ovate or elliptic, toothed; calyx saccate, lower teeth short; nutlets black at maturity, never glaucous, orbicular in outline or nearly so, not at all mucilaginous when moistened. Plants of South America and eastern North America. ..... IV. Subgenus HEDEOMA

KEY TO THE TAXA OF THE SUBGENUS *CILIATUM*

1. Leaves with regularly spaced costae on the undersurface and finely ciliate margins; calyces densely pubescent on the inner faces of the teeth; plants of Mexico.
   2. Plants 5.0–10.0 cm tall; leaves elliptical-lanceolate, 5.0–10.0 mm long; corolla bright orange-red, large and showy, over 25.0 mm long.
      1. *H. ciliolatum*
   2. Plants 3.0–5.0 cm tall; leaves ovate, 3.5–5.0 mm long, corolla lavender, less than 15.0 mm long.
      2. *H. pusillum*
1. Leaves smooth or tuberculate on the undersurface but without regularly spaced costae, margins pilose or tuberculate-ciliate; calyx teeth glabrous on their inner faces; plants of U.S.
   3. Plants ca 4.0 cm high; leaves ovate, ca 5.0 mm long, calyces pilose.
      3. *H. pilosum*
   3. Plants 10.0–15.0 cm high, leaves, lanceolate-elliptic, ca 10.0 mm long, calyces hispidulous.

4. Leaves obtuse or acute at apex; corolla ca 30.0 mm long, orange-red. 4. *H. todsenii*

4. Leaves apiculate at apex; corolla ca 20.0 mm long, pink. 5. *H. apiculatum*

KEY TO THE TAXA OF THE SUBGENUS *POLIOMINTHOIDES*

1. Plants with simple unbranched hairs; Mexico
   2. Tall shrubs, with axillary 15-31 flowered cymules, commonly aggregated into dense terminal spikes. ..... 6. *H. palmeri*
   2. Spindly shrubs or suffruticose perennials with 1-5 flowered cymules not usually aggregated.
      3. Spindly shrubs with the upper calyx teeth narrowly triangular and reflexed away from the axis; calyx annulus more or less included. ..... 7. *H. patrinum*
      3. Suffruticose perennials with the upper calyx teeth subulate and, at least partially, convergent with the lower at maturity; calyx annulus well-exserted. ..... 8. *H. montanum*
1. Plants covered by a tomentum of highly branched hairs; Texas. ..... 9. *H. molle*

KEY TO THE TAXA OF THE SUBGENUS *SATUREJOIDES*

1. Plants perennial herbs with the shoots decumbent and rhizomatous in some species; leaves ovate, elliptical, oblong, or lanceolate, margins entire or obscurely toothed, base tapered and subsessile; upper calyx lip broad; corolla showy, the upper lip commonly reflexed; nutlets orbicular or ovate in outline, less than twice as long as wide; plants of the Sierra Madre Occidental of western Mexico. ..... A. sect. *Alpine*
   2. Plants with numerous ascending and decumbent shoots producing adventitious roots from the lower nodes; nutlets spherical or nearly so.
      3. Leaves oblong or oblanceolate; cymules congested toward the branch apices; calyx large, tubular-funnelform, ca 8.0 mm long, 2.0–2.5 mm wide at the summit, the tube not at all gibbous.
         4. Leaves crowded with the internodes uniformly 1.0 mm long, leaves 6.5–7.0 mm long, with conspicuous decurrent bases; calyx glabrous; upper calyx lobes narrowly triangular, acuminate at the apex; plants of S. Am. ..... 10. *H. polygalaefolium*
         4. Leaves well-spaced, 10.0–17.0 mm long, the bases not decurrent; calyx hirtellous; upper calyx lobes deltoid or semi-ovate; plants of N. Am. ..... 11. *H. bellum*
      3. Leaves elliptical, ovate or subrotund; cymules well-spaced along the axis; calyx zygomorphic, 5.5–7.0 mm long, 1.5 mm wide at the summit, the tube gibbous or saccate.
         5. Leaves ovate to narrowly elliptical; the calyx tube slightly gibbous, the upper calyx lobes triangular; corolla 11.0–12.0 mm long. ..... 12. *H. jucundum*
         5. Leaves ovate to sub-orbicular; the calyx tube conspicuously saccate, forming a distinct pouch, the upper calyx lobes semi-ovate or deltoid; corolla 7.0–8.5 mm long. ..... 13. *H. piperitum*
   2. Plants with shoots ascending; nutlets ovoid; leaves with odor of oregano.
      6. Cymules well-spaced along the upper $\frac{2}{3}$ of the stems; calyx 4.0–6.5 mm long; corolla 7.0–9.0 mm long. ..... 14. *H. patens*
      6. Cymules aggregated toward the branch apices forming a short terminal "spike" of cymules; calyx 3.0–3.5 mm long; corolla 5.0–6.0 mm long. ..... 15. *H. floribundum*

1. Annuals or perennials, the shoots and leaves various; upper calyx lip not usually broad, or if so, then plants annual; corolla various, the upper lip straight or if reflexed markedly then plants annual; nutlets oblong, ca twice as long as wide; plants variously distributed, but not in the Sierra Madre Occidental of western Mexico. ..... B. sect. *Saturejoides*
   7. Plants perennial, or annual with the calyx teeth strongly convergent and closing the calyx orifice, or with the corolla tube markedly inflated.
      8. Upper and lower calyx teeth convergent, closing the calyx orifice at maturity, or if only slightly so, then plants with entire, long, elliptical-oblong leaves and large corolla, 10.0–14.0 mm long, the lower lip 7.0 mm wide.
         9. Calyx tube gibbous but not saccate, not tapered upwardly; upper calyx teeth united and only slightly convergent with the lower teeth; plants of the mountains of south central New Mexico. ..... 16. *H. pulcherrimum*
         9. Calyx tube conspicuously saccate and tapered into a narrow neck; the upper calyx teeth, clearly convergent with the lower; plants of various habitats and distribution.
            10. Upper calyx teeth ununited, subulate; nutlets areolate; plants of N. Am.
               11. Plants annuals or herbaceous perennials, occasionally somewhat woody at the base, averaging less than 25.0 cm in height; leaves bright green, over three times longer than wide; calyx weakly hirsute, the upper and lower teeth usually strongly convergent; corolla 7.0–11.0 mm long; widespread; odor of peppermint. ..... 17. *H. drummondii*
               11. Plants suffruticose typically averaging over 25.0 cm in height; leaves gray or dark green, usually less than three times longer than wide; calyx coarsely hirsute or hoary villous, the upper and lower teeth incompletely closing the orifice; corolla 8.0–15.0 mm long; west and central Texas to south-central Oklahoma; odor of camphor or lemon. ..... 18. *H. reverchonii*
            10. Upper calyx teeth united, triangular; nutlets foveate; plants of S. Am. ..... 19. *H. multiflorum*
      8. Calyx teeth not as above, the upper teeth generally spreading and reflexed at maturity leaving the calyx tube open.
         12. Leaves ovate and entire, calyx conspicuously short and gibbous-saccate, the distended region $\frac{1}{2}$ of the length of the tube.
            13. Leaves ovate, acute; corolla often dilated upwardly; nutlets areolate; plants of N. Am.
               14. Plants with numerous decumbent stems, forming circular mats; calyx gibbious but not saccate, the upper lip pubescent on its inner face; corolla ca 9.5 mm long, restricted to the pine forests of north-central Arizona (Flagstaff). ..... 20. *H. diffusum*
               14. Plants of various habits but not as above; calyx saccate; the upper lip glabrous within; corolla 8.0–9.0 mm long, southwestern U.S. and Mexico.
                  15. Leaves entire and smooth; widespread. ..... 21. *H. nanum*
                  15. Leaves denticulate, costate; endemic to central Mexico. ..... 22. *H. microphyllum*
            13. Leaves linear-elliptical; corolla not dilated upwardly; nutlets foveate; plants of S. Am. ..... 23. *H. medium*
         12. Leaves commonly toothed (entire and ovate in the two species from Baja, California); calyx tubular or sigmoid, the distended region less than $\frac{1}{2}$ the length of the tube.

16. Tufted perennials with the shoots freely branching; axillary leaf buds not usually occurring; leaves oval, ovate, linear or elliptic, plants of central and eastern Mexico, Texas, and Southeastern New Mexico.
    17. Leaves serrate or dentate; ovate, elliptic, rhombic or oblanceolate.
        18. Leaves ovate, oval or elliptic; leaf nerves distinct but not elevated, curved and branched; calyx annulus seated at the juncture of upper and lower lips. ..... 24. *H. costatum*
        18. Leaves ovate, oblanceolate, elliptic or rhombic; leaf nerves elevated and straight; calyx annulus seated below the juncture of upper and lower lips.
            19. Leaves ovate-oblanceolate, dentate; calyx well over 10 mm long; corolla showy, over 30 mm long; known only from the Sierra Jardin of northern Mexico. ..... 25. *H. johnstonii*
            19. Leaves elliptic or rhombic, coarsely serrate; calyx ca 8.0 mm long; corolla 7.0–10.0 mm long; widespread. ..... 26. *H. plicatum*
    17. Leaves entire or obscurely crenate; ovate, elliptic or lanceolate.
        20. Leaves elliptical or ovate; plants of Baja California.
            21. Leaves 9.0–13.5 mm long; internodes elongated; cymules 1–3 flowered. ..... 27. *H. tenuiflorum*
            21. Leaves 5.0–6.0 mm long; internodes short; flowers solitary in the upper leaf axils. ..... 28. *H. martirense*
        20. Leaves lanceolate (at least the upper); plants of eastern Mexico.
            22. Axillary cymules 1–3 flowered; calyx 7.0–8.0 mm long; corolla ca 17.0 mm long, well exserted from the calyx. ..... 29. *H. quercetorum*
            22. Axillary cymules many-flowered; calyx 5.0–6.0 mm long; corolla ca 5.5 mm long, barely exserted from the calyx. ..... 30. *H. tenuipes*
16. Tall robust plants with long ascending, usually unbranched shoots; axillary leaves (forming early in the development of the shoots) present and yielding a cluster of 2–3 small leaf pairs; leaves linear-lanceolate or elliptical-ovate; plants of western New Mexico and eastern Arizona, occasionally in northwestern Mexico.
    23. Leaves linear or narrowly elliptical, entire, and subsessile; cymules 1–7 flowered; calyx slightly gibbous; corolla large and showy, 11.0–16.0 mm long, ca 7.0 mm wide across the lower lip. ..... 31. *H. hyssopifolium*
    23. Leaves elliptical, dentate or denticulate, shortly petiolate or subsessile; cymules 1–15 flowered; calyx markedly gibbous; corolla 8.0–11.0 mm long, 3.5–4.0 mm wide across the lower lip.
        24. Basal leaves ovate, glabrous, entire. ..... 32. *H. oblongifolium*
        24. Basal leaves ovate-rhomboid, densely pubescent, dentate. ..... 33. *H. dentatum*
7. Plants annual, the calyx teeth not convergent or the corolla markedly dilated.
    25. Leaves ovate, elliptical, or rhombic-elliptical, dentate, or entire, petiolate; calyx saccate for ca $\frac{1}{3}$ of the tube's length; corolla only occasionally cleistogamous. ..... 34. *H. acinoides*
    25. Leaves linear or linear-elliptic, at least five times longer than wide, entire sessile; calyx saccate for over $\frac{3}{4}$ of the tube's length; the upper lip of the corolla straight, corolla often cleistogamous. ..... 35. *H. hispidum*

KEY TO THE TAXA OF THE SUBGENUS *HEDEOMA*

1. Plants annual; leaves elliptical and dentate; plants of N. Am. .... 36. *H. pulegioides*
1. Plants perennial; leaves ovate, obovate, spatulate, crenate or entire; plants of S. Am.
    2. Leaves distinctly crenate; calyx markedly saccate, ca 4.0 mm long; corolla ca 3.0 mm long, Brazil. ..... 37. *H. crenatum*

2. Leaves obscurely crenate, mostly entire; calyx gibbous or only slightly saccate, 4.0–5.0 mm long, corolla 5.0–8.5 mm long, Bolivia and Peru. ..... 38. *H. mandonianum*

I. Subgenus **CILIATUM,** Irving, subg. nov.

Herba casespitosa vel tegeta, 4–12 cm alta; caules herbacei numerosi simplices; folia conferta, coriacea, ovato vel elliptico–lanceolata, integra, sessilia, 3.5–15.0 mm longis, 1.5–3.5 mm lata, margine conspicue ciliata; cymae triflorae vel flores singulares; calyx infundibuliformis vel leviter tubularis; corolla grandis speciosa; mericarpium oblongum madefactum mucilaginum; chromosomatum numerus $2n = 36$, 144.

Plants casespitose, often forming dense mats, 4.0–12.0 cm in height. Stems herbaceous, numerous, unbranched, arising from a woody caudex or trailing rootstock. Leaf pairs crowded, the internodes shorter than 2.0 mm; leaves coriaceous ascending, usually folded with drying, ovate to elliptical-lanceolate, entire, sessile, 3.5–15.0 mm long, 1.5–3.5 mm wide; margins ciliate, the upper and lower leaf surfaces glabrate to puberulent; nervation prominent or inconspicuous; undersurface to varying degrees glandular-punctate between the costae, the upper surface smooth. Flowers typically solitary in the upper leaf axils or in three-flowered cymules (*H. apiculatum*). Calyx tubular-funnelform, not at all gibbous below, distinctly bilabiate in both the tube and disposition of the teeth, 5.0–10.0 mm long; the upper teeth united for ¼–½ their length, forming an upper lip, the lobes triangular or deltoid; the lower teeth narrow, triangular; the annulus dense and included. Corolla lavender, pink or red, usually large and showy, 10.0–32.0 mm long, pubescent within. Nutlets oblong in outline, at least twice as long as wide, ovate–triangular in cross section, brown at maturity, the surface areolate, glaucous, becoming mucilaginous when moistened. Chromosome number, $2n = 36$, 144.

Type species: Hedeoma ciliolatum Epl.

1. Hedeoma ciliolatum (Epl.) Irving, Brittonia 22: 345. 1970.

Hesperozygis ciliolata Epl., Rep. Spec. Nov., Beihefte 115: 13–14. 1939.

Somewhat robust perennials forming dense clumps 7.0–12.0 cm (10.0 cm) high. Stems numerous, unbranched or only sparsely so, canescent with short retrorse hairs. Leaves coriaceous, folded with drying, elliptical-lanceolate, entire, sessile, 1.7–2.5 mm (2.0 mm) wide, 5.0–10.0 mm (8.4 mm) long; tapered to a narrowly obtuse or acutish apex, margins distinctly ciliate; upper and lower surface glabrous; nerves of 4–5 prominent pairs, leaves smooth above, punctate below. Flowers in the axis of the upper leaves, solitary or rarely in two-flowered cymules, congested somewhat towards the apex; peduncles inconspicuous, ca 1.0 mm in length; pedicels 2.0–4.0 mm long, canescent; bracteoles short, oblong. Calyx coriaceous, 8.0–10.5 mm (9.9 mm) long, the tube tubular-funnelform, 6.5–8.0 mm (7.3 mm) long, 2.0–2.2 mm wide above, densely puberulent; the upper teeth scarcely connate,

forming an upper lip, 1.5–2.1 mm long, the lobes triangular ca 2.6 mm wide at the base, 1.0–2.0 mm long, ciliate; the lower teeth lanceolate, ascending, 1.5–3.0 mm long, ciliate; the annulus dense, included, 0.7–1.0 m wide but extended upwardly into the calyx lobes, seated 1.5–2.0 mm below the juncture of the upper and lower teeth. Corolla brilliant, orange-red, 30.0–32.0 mm (31.0 mm) long, pubescent within on the palate, densely puberulent within the tube, forming annulus ca 4.5 mm wide; the tube, 25.0–27.0 mm long dilated upwardly, 5.0 mm wide above; the upper lip broadly ligulate 5.0 mm wide, ca 6.0 mm long, distinctly emarginate; the lower lip ca 12.0 mm wide, ca 7.5 mm long. Nutlets ca 0.6 mm wide, 1.2 mm long, the surface weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 2). Endemic but abundant on gypsum outcrops in open, mature, pine forests in the vicinity of Galeana, Nuevo Leon. 4,000–6,000 ft. Jul–Sep.

TYPE: NUEVO LEON. 15 mi southwest of Galeana, 18 Jul 1934, *C. H. & M. T. Mueller 1062* (Holotype, LA!; isotypes, F! GH! MICH! TEX!).

There are several features of *H. ciliolatum* which suggest an alliance to *Poliomintha*. Its large, brightly colored corolla is scarcely distinguishable from the corolla of *Poliomintha longiflora*, and its inner calyx pubescence is suggestive of the *P. longiflora–P. glabrescens* complex. However, its habit and clear alliance to *H. pusillum*, strongly support its inclusion in the subgenus *Ciliatum*. In no way can I see any alliance to the South American representatives of the genus *Hesperozygis* nor to its sole North American representative, *H. marifolia*, as was suggested earlier by Epling (1939).

2. HEDEOMA PUSILLUM (Irving) Irving, Brittonia 22: 345. 1970.

Hesperozygis pusilla Irving, Brittonia 19: 245–247. 1967.

Small, perennial, caespitose herbs, 3.0–5.0 cm high, forming mats. Stems numerous, unbranched, canescent with short retrorse hairs. Leaves coriaceous, folded with drying, ovate, entire, sessile, 1.5–2.1 mm (1.8 mm) wide, 3.5–5.0 mm (4.7 mm) long, tapered to a narrowly obtuse or acutish apex, margins finely ciliate, both surfaces evenly puberulent with short appressed hairs; nerves of 4–5 prominent pairs; leaves smooth above, punctuate below. Flowers solitary in the upper leaf axils, congested toward the apex; peduncles short, less than 1.0 mm in length; pedicels 1.0–2.0 mm long, canescent; bracteoles short, ovate-oblong. Calyx 5.2–7.0 mm (6.2 mm) long, coriaceous; the tube tubular-funnelform, 4.5–5.5 mm (5.0 mm) long, densely puberulent; the upper teeth connate for 1/4–1/3 of their length, forming an upper lip, the lobes 1.0–1.5 mm wide at the base, ca 0.7 mm long, the central lobe commonly reduced to about 1/2 the width and height of the two adjacent lobes, the lobes slightly laterally spreading and reflexed; the lower teeth lanceolate, short, ascending, ca 1.0 mm long, densely puberulent on the inner face; the annulus included, dense, ca 0.5 mm wide,

extending into the calyx lobes, seated ca 0.5 mm below the juncture of the upper and lower teeth. Corolla lavender, 10.0–11.0 mm (10.5 mm) long, pubescent within but not annulate; the tube, 8.5–9.5 mm long, only slightly dilated upwardly, ca 2.5 mm wide above; upper lip ligulate, subgaleate, straight, 1.5 mm wide, ca 1.5 mm long, distinctly emarginate; the lower lip ca 3.5 mm wide, ca 2.0 mm long. Nutlets ca 0.5 mm wide, 1.0 mm long, the surface, weakly or not at all glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 2). Known only from the pine forests south of Galeana, Mexico; often sympathic with *H. ciliolatum.*

TYPE: NUEVO LEON. 2.5 mi south of Galeana near junction of road to Linares, 5–7 Aug 1965, *Irving 471* (Holotype, TEX! isotypes, LA! SMU! TEX! MONTU!).

In general, *H. pusillum* is a diminutive counterpart of *H. ciliolatum.* The quantitative differences being reflected to some degree in all of the morphological features. The most conspicuous departure of *H. pusillum* is in its small (10.0–11.0 mm.) lavender corolla which is in marked contrast to the long (30.0–32.0 mm), orange-red corolla of *H. ciliolatum.*

3. HEDEOMA PILOSUM Irving, Brittonia 22: 340-342. 1970.

A small perennial, caespitose herb ca 4.0 cm high, probably forming mats. Stems extremely short, unbranched above, profusely branched below, pubescent with short spreading hairs. Leaves coriaceous and sharply ascending, appressed to the stems, ovate, entire, sessile, 5.0 mm long, 2.5–3.0 mm (2.7 mm) wide; tapered to a narrowly obtuse or acutish apex, margins short pilose-ciliate, both upper and lower surfaces glabrous; nerves of 1–2 slightly raised subopposite pairs. Flowers solitary in the uppermost leaf axils; peduncles short; pedicels 1.0–2.0 mm long, canescent; bracteoles short, oblong, ciliate. Calyx 7.5 mm long, somewhat coriaceous, the tube tubular-funnelform, dilated upwardly, ca 5.0 mm long, pilose, the hairs long and spreading; the upper teeth connate for ca 1/2 of their length, forming a conspicuous, broad upper lip, ca 2.4 mm long, the lobes triangular, ca 0.5 mm wide at the base, ca 1.2 mm long, laterally slightly spreading and reflexed, pilose ciliate; the lower teeth narrowly triangular-lanceolate, ascending, ca 2.5 mm long, pilose-ciliate; annulus dense, included, ca 1.1 mm wide but seated deep within the tube at ca 2.0 mm below the juncture of the upper and lower lips. Corolla, nutlets unknown. Chromosome number, unknown.

Distribution (Fig. 2). Known only from the type locality. Open, exposed limestone, 5,000-6,000 ft. Jul.

TYPE: TEXAS. Brewster Co., near top of Baldy Peak, Glass Mountains, 13 Jul 1940, *Warnock 352* (Holotype GH!).

Hedeoma pilosum seems to be intermediate between *H. pusillum* and *H. apiculatum* but due to the incompleteness of the specimen this position is tentative. Unfortunately a revisit to the type locality did not reveal any trace of *H. pilosum* and it may well be extinct.

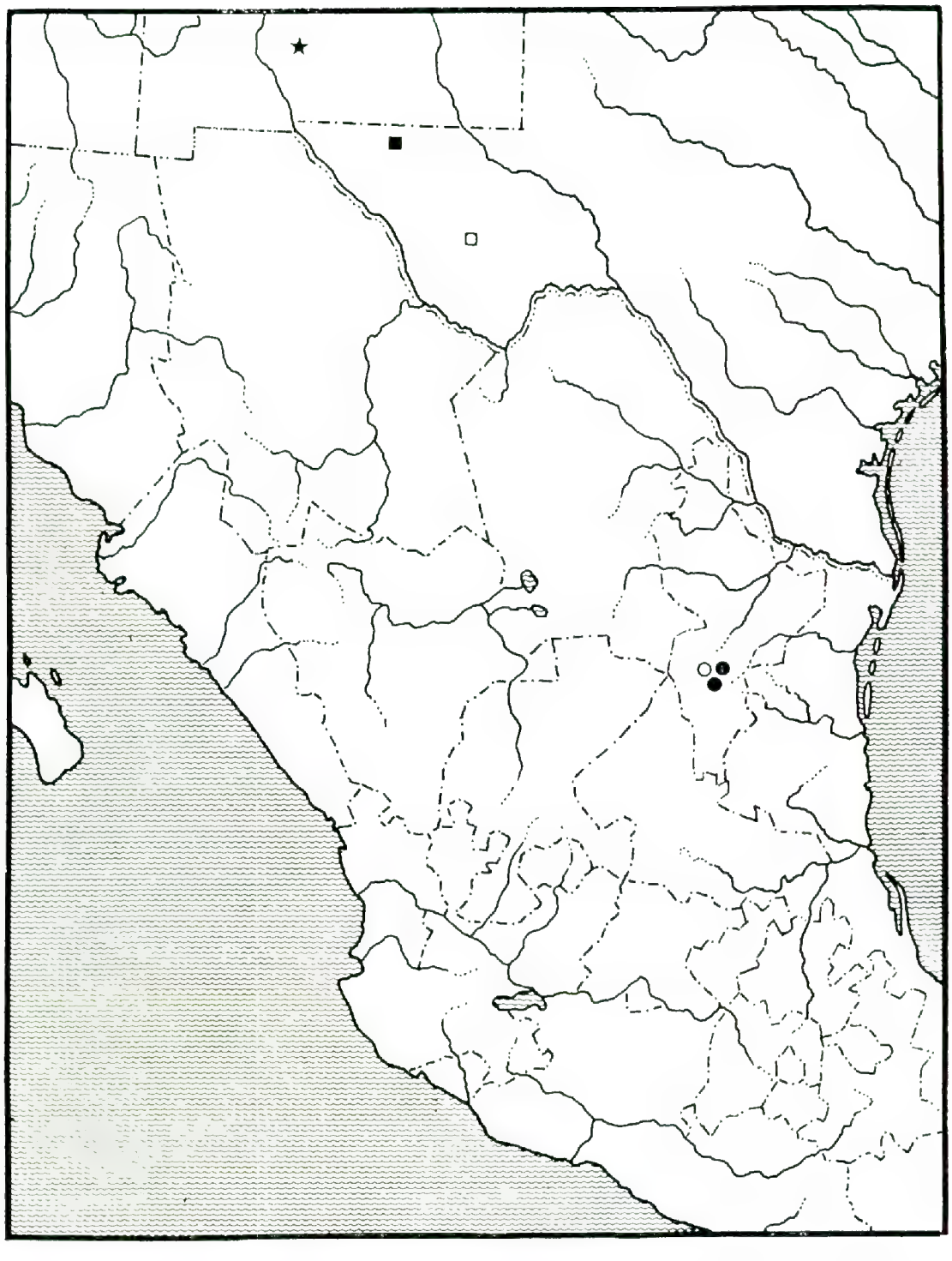


Fig. 2. Distribution of *Hedeoma ciliolatum* (closed circles), *H. pusillum* (open circles), *H. pilosum* (open square) and *H. apiculatum* (closed square), *H. todsenii* (star).

4. HEDEOMA TODSENII Irving, Madroño 26: 184–187. 1979.

Suffrutescent caespitose perennials 10.0 to 18.0 cm high. Stems numerous, simple, canescent or puberulent with hairs retrorsely curling. Leaves coriaceous, entire, lanceolate-elliptic, subsessile, 8.0–14.0 mm long, 2.0–4.0 mm wide; apex obtuse to slightly mucronate; midrib and margins slightly hispidulose-tuberculate; lower surface deeply glandular punctuate, the upper less so. Flowers solitary and well-spaced in the upper portions of the stems; peduncles ca 1.5 mm long; pedicels ca 3.5 mm long, canescent; bracteoles lanceolate longer than pedicels. Calyx 11.0–12.0 mm long (base to tip of teeth), tubular-funnelform, not gibbous, minutely scabrous on the nerves and glandular punctate between; upper teeth partially connate forming a conspicuously reflexed upper lip, the lobes lanceolate, ca 1.0 mm wide, 1.5 mm long, sparsely ciliate; lower teeth ascending, deltoid-aristate, 3.0–3.5 mm long, sparsely hirsute-ciliate; annulus ca 1.0 mm wide, included and seated ca 2.0 mm below the juncture of the upper and lower teeth. Corolla orange-red, ca 30.0 mm long, 6.0 mm wide at the throat, sparsely pubescent in the tube but not annulate; the upper lip deeply obcordate, erect, up to 5.0 mm long, red in color on the interior margins; lower lip streaked with red, reflexed, the similar rounded lobes ca 3.5 mm long, 3.0 mm wide; anthers exserted. Nutlets ca 2.0 mm long, 1.0 mm wide, dark brown in color and weakly glaucous. Chromosome number, unknown.

Distribution (Fig. 2). Known only from the type locality. Open, exposed limestone slopes. Aug–Sept.

TYPE: NEW MEXICO, Sierra Co., San Andres Mts., On steep north-facing gravelly gypseous limestone hillside in open pinyon, 2 km s of Hardin Ranch, 18 Aug 1978, *T.K. Todsen SA 1–78* (Holotype, NY; isotypes, NMSU US! TEX!).

Hedeoma todsenii is most closely allied to *H. apiculatum*. The suffruticose habit; the overall patterns of pubescence; the coriaceous, entire, lanceolate leaves and the large tubular calyx with its deep seated annulus are some of the morphological attributes which are nearly identical in both taxa.

5. HEDEOMA APICULATUM Stewart, Rep. Spec. Nov., Beihefte 115: 25. 1939.

Small, suffrutescent perennials, 10.0–15.0 cm (12.0 cm) high, forming mats. Stems numerous, unbranched, densely clothed in minute retrorsely curling hairs. Leaves coriaceous, somewhat folded upon drying, lanceolate-elliptic (occasionally ovate below), entire, sessile, 1.5–3.5 mm (2.5 mm) wide, 7.0–15.0 mm (10.0 mm) long, tapering to a conspicious but short apiculate apex, sparsely hispiduluse-tuberculate on veins and margins; nervation indistinct; upper surface smooth, lower rugose and punctuate. Flowers solitary or in 2–3 flowered axillary cymules, crowded toward the apex; peduncles short, 1.0–1.5 mm long, pedicels 3.0–4.0 mm long, canescent, bracteoles narrowly lanceolate. Calyx 8.5–9.0 mm (8.8 mm) long, chartaceous; the

tube tubular-funnelform, flaring above, 5.5–6.5 mm (6.0 mm) long, 1.5–1.8 mm wide below to 2.0–3.0 mm wide above, minutely hispidulose-tuberculate below, glabrous above; the upper teeth connate for ca 1/4 or less of their length, forming an upper lip 2.0–2.2 mm long, the lobes broadly triangular or deltoid, apiculate at their apices, ca 1.0 mm wide at the base, 1.0–1.5 mm long, laterally spreading and reflexed, hirtellous and tuberculate-ciliate; the lower teeth ascending, broadly to narrowly triangular-aristate, ca 1.2 mm wide at the base, ca 3.0 mm long, conspicuously hirsute-ciliate; annulus dense, ca 1.2 mm wide, with long pilose hairs, seated ca 1.5 mm below the juncture of the upper and lower teeth. Corolla pink, showy, 19.0–20.0 mm long, pubescent in the throat, sparsely pubescent within the tube; the tube ca 10.0 mm long conspicuously dilated upwardly, ca 4.0 mm wide above; the upper lip broadly obcordate in outline, ca 5.0 mm wide, ca 5.0 mm long, the lower lip broad, 9.0–10.0 mm wide, ca 8.5 mm long. Nutlets somewhat pointed at their apex, ca 2.0 mm long, 0.7–0.9 mm wide, the surface weakly glaucous. Chromosome number, $2n = 144$.

Distribution (Fig. 2). Restricted to the Guadalupe Mountains of Texas and New Mexico, frequent among rocks of the streamway and canyon sides in the south fork of McKittrick Canyon and in the limestone crevices atop adjacent Pine Top Mountain. 5,000-8,000 ft. Jul–Aug.

TYPE: TEXAS. Culberson Co., Guadalupe Mts., sunny crevices along stream, McKittrick Canyon, 22 Aug 1931, *Moore & Steyermark 3563* (Holotype, LA!; isotypes, CAS! DS! GH! MICH! NY! PH!).

II. SUBGENUS **POLIOMINTHOIDES** Irving, subg. nov.

Suffruticosum 15.0–100.0 cm altae incani ad basin valde lignosi; folia crassa membranacea, rotunda, ovata vel elliptica, integra vel dentata, petiolata, 5.0–30.0 mm longa, 2.0–15.0 mm lata; cymulae axillares 3–31 flori, terminales densi interruptique, aggregatae; calyx tubularis, calycis dentes, subulati; series superae et interae minime distincti; corolla magna speciosa; mericarpum oblongum madefactum mucilaginum; chromosomatum numerous, $2n = 36$.

Suffrutescent perennials, or semi-shrubs, 15.0–100.0 cm tall. Shoots woody below, herbaceous above, ascending or shortly decumbent, arising from a woody caudex or short woody taproot, canescent. Leaves canescent and glandular punctuate, thick-membranous, rotund, ovate, or elliptical, 2.0–15.0 mm wide, 5.0–30.0 mm long, margins entire or dentate; apex acute or obtuse; base narrowly attenuated and petiolate. Axillary cymules, 3–31-flowered, well-space along the upper 1/3–1/2 of the stems, or commonly aggregated into dense, interrupted terminal spikes. Calyx more or less radially symmetrical and tubular, 5.0–8.0 mm long, pubescent evenly distributed; calyx teeth only slightly differentiated into upper and lower sets (to be greater extent in *H. patrinum*), the upper teeth commonly subulate and scarcely united to form the upper lip; the lower teeth subulate; annulus dense and well-formed. Corolla white to lavender, large and showy, over

13.0 mm long, variously pubescent within, the tube dilating upwardly; upper lip ligulate to obcordate, emarginate; lower lip spreading. Nutlets oblong in outline, over twice as long as wide, brown at maturity with the surface areolate, glaucous and becoming mucilanginous when moistened. Chromosome number $2n = 36$.

Type species: HEDEOMA PALMERI Hemsl.

6. HEDEOMA PALMERI Hemsl., Biol. Cent. Am. 2: 548. 1881.

Hedeoma rotundifolium Hemsl., Biol. Cent. Am. 2: 549. 1881. Type: HIDALGO: "Zimapan," *Coulter 1081* (Holotype, K!; phototypes, GH! LA! NY! PH! US!).

Robust, suffrutescent perennials 35.0–100.0 cm (58.8 cm) high. Shoots long, ascending or erect, arising from a woody caudex, branching sparse but occurring freely along the axis with the branches diverging at wide angles, densely pubescent or puberulent (in many representatives nearly cinerous) the hairs retrorsely curving or curling. Leaves variable, ovate or subrotund, 6.0–15.0 mm (11.5 mm) wide, 10.0–30.0 (20.0 mm) long; margins crenate or dentate, rarely entire; apex obtuse; base broadly or narrowly attenuated, petiolate with the petiole 2.5–6.0 mm long; pubescence highly variable, the under-surface varying from tomentose to simply pubescent, the margins and upper surface glabrate to pubescent; nerves not prominent. Axillary cymules 15–31-flowered, occurring along the upper 1/3–1/2 of the stems and commonly terminating in a dense interrupted spike; primary peduncles ca 1.5 mm; pedicels ca 1.0 mm long, inconspicuous; bracteoles narrowly lanceolate usually longer than the pedicels they subtend and frequently as long or longer than the calyx tube (short in *University of Illinois collection 994; Mueller 2707, 2995b*). Calyx 5.0–8.0 mm (6.3 mm) long, the tube radically symmetrical, 3.0–4.0 mm (3.5 mm) long, ca 1.1 mm wide in diameter, somewhat dilated upwardly, puberulent or densely long pilose (*Irving 669, Shreve & Tinkham 9779a, Cummins 23-63*), calyx teeth only slightly differentiated into upper and lower lips; the upper teeth scarcely connate, the lobes long subulate (occasionally triangular), commonly exceeding the lower in length, 1.9–3.7 mm (2.6 mm) long, erect and outwardly spreading; the lower teeth subulate, 2.0–3.3 mm (2.5 mm) long, erect and outwardly spreading; the annulus well-exserted, undulating, ca 0.7 mm wide and seated at the juncture of the upper and lower teeth. Corolla blue-lavender, 14.0–16.0 mm (15.0 mm) long, pubescent within but not annulate; the tube and throat together 9.0–10.0 mm (9.5 mm) long, conspicuously dilated upwardly, about 3.0 mm wide above; the upper lip broadly to narrowly ligulate, emarginate, 2.0–3.5 mm wide, 5.0–6.0 mm long, the margins and apex revolute; lower lip 5.0 mm wide, 5.0–7.0 mm long. Nutlets ca 0.5 mm wide, 1.0 mm long, the surface minutely areolate and weakly gluacous. Chromosome number, $2n = 36$.

Distribution (Fig. 3). Abundant in a variety of habitats from Galeana, Nuevo Leon, south to Zimapan, Hidalgo. It is especially prominent near the

city of San Luis Potosi. The habitats range from upper montane pine forests where the plants occur in open, rocky, exposed areas to the relatively xerophytic habitats at lower elevations, where the plants abound on open, rocky exposed areas (e.g., stabilized talus slopes), 5,000-10,000 ft. Jul–Sep.

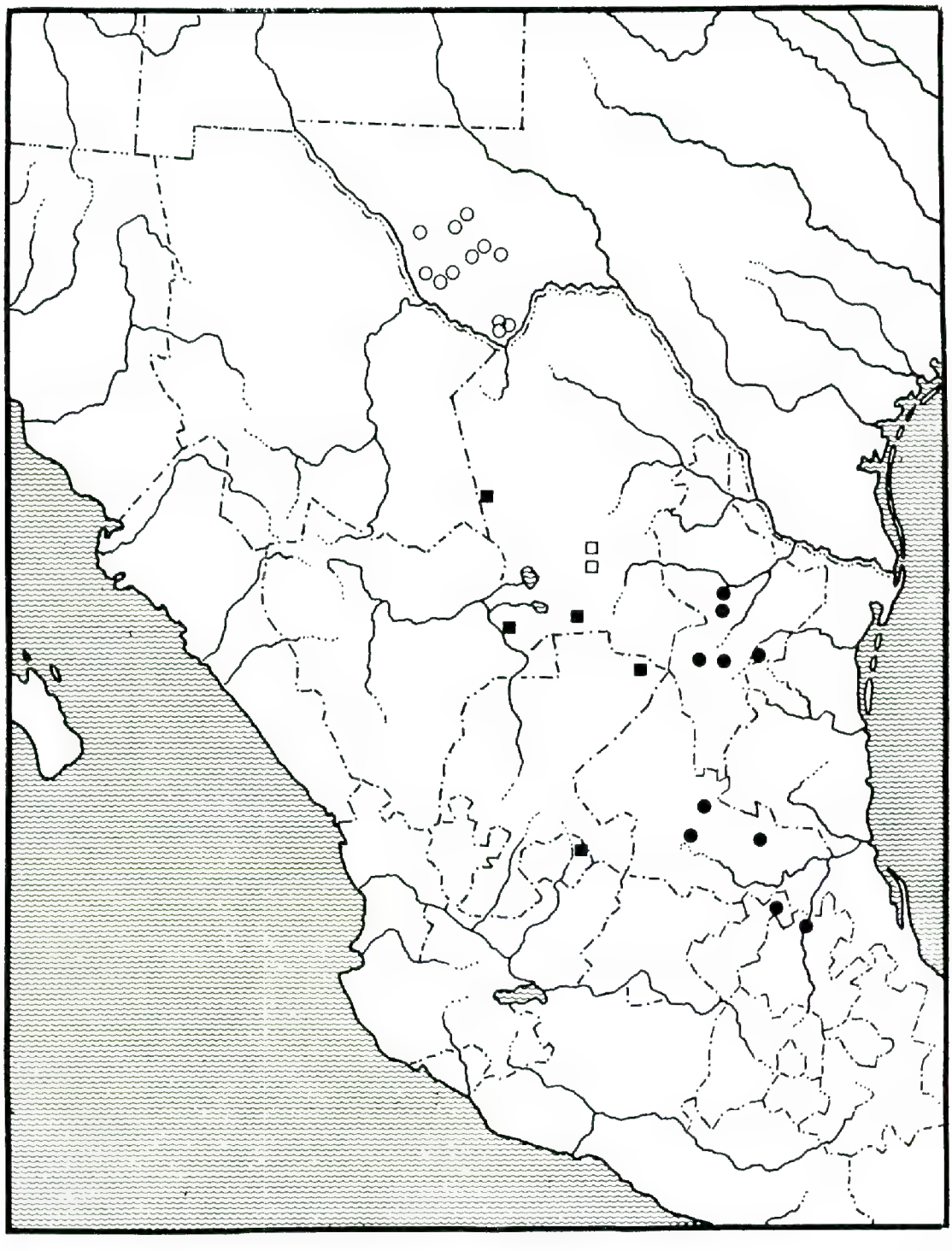


Fig. 3. Distribution of *Hedeoma palmeri* (closed circles), *H. molle* (open circles), *H. patrinum* (closed squares) and *H. montanum* (open squares).

TYPE: SAN LUIS POTOSI: chiefly in the region of San Luis Potosi, 22° N. Lat., Alt. 6,000–8,000 ft., 1878, *Parry & Palmer 728* (Holotype, K! isotypes, F! LA! MICH! NY! PH! US!; phototype, LA!).

Hedeoma palmeri is quite variable and its populations form a mosaic of morphological patterns. Because of this, no attempt has been made to subdivide the species into subspecific categories.

The densely tomentose populations growing in the Galeana area (the most northern part of *H. palmeri's* range) are especially difficult to treat. In the words of Epling (unpublished notes), "these specimens [from Galeana] are such an extreme as to provoke a review of this species." I.M. Johnston, according to information on herbarium labels (*Shreve & Tinkham 9779a*), thought the plants represented an undescribed species. However, these workers examined only a few extreme specimens which gave a somewhat distorted picture. When many representatives are brought together, the extremes grade one into another.

Hedeoma palmeri is quite variable and its populations form a mosaic of morphological patterns. Because of this, no attempt has been made to subdivide the species into subspecific categories.

7. HEDEOMA PATRINUM Stewart, Rep. Spec. Nov., Beihefte 115: 45. 1939.

Spindly, suffruticose perennials or semi-shrubs, 15.0–62.0 cm (31.4 cm) high. Shoots ascending, or commonly shortly decumbent, rhizomatous producing adventitious roots at the lower nodes, arising from a slender taproot, branching freely along the axes with the branches divergent at wide angles, cinerous above with short retrorsely curling hairs (occasionally spreading), glabrous below with exfoliating bark. Leaves deciduous from the lower portion of the stems, spreading, ovate or elliptic, 3.0–5.5 mm (4.2 mm) wide, 5.2–10.0 mm (7.6 mm) long; margins entire or occasionally obscurely dentate in the upper 1/2 of the blade (*Purpus 4588*); apex broadly acute or obtuse; based broadly cuneate or rounded, petiole 1.0–1.7 mm long; upper surface densely puberulent, margins and undersurface cinerous and tomentulose; nervation inconspicuous. Axillary cymules 1–3 flowered, well-spaced along the upper 1/4 of the branches; primary peduncles (and also secondaries) conspicuous, 1.0–2.5 mm long; pedicels 1.7–3.0 mm long, cinerous or simply pubescent; bracteoles subulate, 1.0–2.0 mm long, shorter than the pedicels they subtend. Calyx 5.5–8.0 mm (7.0 mm) long; the tube 4.0–5.0 mm (4.9 mm) long, tubular or slightly gibbous below, sparsely or densely pubescent; the upper teeth variously united from scarcely at all (*Mueller 3302*) to forming an upper lip 1.0–1.2 mm long (*McVaugh 23685*), the lobes triangular (deltoid in *McVaugh 23685*) ca 0.4 mm wide at the base, 0.4–0.9 mm long, spreading and outwardly curling at their apices, pubescent on their outer faces but not ciliate or only scarcely so; the lower teeth ascending, recurved, more or less subulate, narrowly triangular, ca 0.5 mm wide at the base 1.5–3.0 mm long, hirsute ciliate; annulus dense, more

or less included, ca 0.7 mm wide and seated at the juncture of the upper and lower teeth. Corolla lavender or blue, 15.0–16.0 mm (15.1 mm) long, glabrous in the throat, hirtellous pubescent in the tube forming a loosely defined annulus ca 5.0 mm wide; the tube and throat together 12.0–13.0 mm (12.5 mm) long gradually dilated upwardly, ca 3.0 mm wide above; the upper lip ligulate flat, straight, 1.8 mm wide, ca 3.0 mm long, very shallowly emarginate; the lower lip considerably larger than the upper, ca 6.0 mm wide, ca 5.5 mm long. Nutlets ca 0.7 mm wide, 1.4 mm long, the surface minutely areolate, and weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 3). Common in the isolated mountains of the Chihuahuan Desert of central Mexico, mostly in oak woodlands, 6,500-8,100 ft. Jun–Sep.

TYPE: ZACATECAS. Concepcion del Oro, Sierra Madre Oriental 2600-2700 m, 18–19 Jul 1934, *Pennell 17432* (Holotype, LA!; isotypes, F! MICH! NY! PH! US!).

Since the original description of *H. patrinum* in 1939, additional collections have considerably expanded the known distribution of this relatively rare species. Notable collections have been made in the Sierra Mojada by Mueller and in the state of Aquascalientes by McVaugh. These have revealed considerable intra-specific variation. The southernmost collection of this species (*McVaugh 23685*) is quite different from the more northern "typical" material. Plants of the former are not cinerous with curling hairs; rather they are pubescent with straight, usually spreading hairs; the upper calyx teeth are well united; and their deltoid lobes approach the foliaceous upper lip found in *H. jucundum* and *H. piperitum.*

The taxonomic position of *H. patrinum* is not certain. Its shrubby habit and entire cinerous leaves indicate an affinity with *H. molle, H. montanum,* and *H. palmeri.* I have therefore, like Epling and Stewart who placed *H. patrinum* between *H. montanum* and *H. molle*, included it in the subgenus *Poliominthoides.*

8. HEDEOMA MONTANUM Brandegee, Univ. Calif. Publ. Bot. 4: 188. 1913.

Robust canescent, suffruticose perennials, 20.0–30.0 cm (28.0 cm) high. Shoots prolific, ascending and arising from a woody caudex or thickened taproot, branching primarily in the lowermost regions with the branches acsending at close angles, canescent with dense, short, spreading or curling hairs. Leaves deciduous from the lower stem regions at maturity, narrowly elliptical, 6.0–10.0 mm (8.0 mm) long, 2.0–3.1 mm (2.6 mm) wide; margins denticulate to dentate. occasionally entire; apex acute; base narrowly attenuated and petiolate, the petiole ca 1.0 mm long, both upper-and lower-leaf surfaces densely cinerous; nerves somewhat elevated. Axillary cymules well-spaced along the upper 1/3–1/2 of the stems, occasionally somewhat congested, typically 1–5-flowered; primary peduncles inconspicuous less than 0.5 mm long; pedicels ca 2.0 mm long, cinereous; bracteoles subulate, ca

3.0 mm long, longer than the pedicels they subtend. Calyx 6.0–8.0 mm (7.1 mm) long; the tube radially symmetrical or nearly so, ca 1.2 mm in diameter, cinereous with tightly curled puberulent hairs evenly distributed from the calyx base to the teeth apices; the calyx teeth only slightly differentiated into upper and lower sets and convergent at maturity; the upper teeth scarcely united for a 1/10 of their length, the upper lip 1.0–2.5 mm long, the lobes slightly shorter than the lower, subulate, ca 0.3 mm wide at the base 0.8–2.5 mm long; lower teeth subulate, recurved but convergent with the upper at maturity, ca 0.5 mm wide at the base, 1.0–2.5 mm long, hirtellous-ciliate; annulus extremely dense, well-exserted, ca 1.0 mm wide, seated approximately at the juncture of the upper and lower teeth. Corolla blue-lavender, ca 15.0 mm long, densely annulate at the juncture of the tube and throat; the tube and throat together ca 12.0 mm long, widening upwardly, ca 3.0 mm wide above; the upper lip ligulate, ca 2.5 mm wide, ca 3.0 mm long, straight, slightly emarginate and concave; the lower lip ca 4.0 mm long, 4.0 mm wide. Nulets ca 0.5 mm wide, ca 1.5 mm long, the surface minutely aerolate nearly smooth and glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 3). Arid mountains of southern Coahuila in the Chihauhuan Desert. Frequent on open, exposed, limestone ridges and hillsides, commonly associate with *Agave lecheguilla*. 7,000-8,000 ft. Jun; Sept–Oct.

TYPE: COAHUILA. Sierra de la Paila, 7,000–8,000 ft. Oct 1910, *Purpus 4964* (Holotype, UC!; isotypes, BM! F! GH! LA! US! phototype, LA!).

Hedeoma montanum is a rather rare species being known by only a few collections from a relatively restricted area of southern Coahuila. It is most closely related to *H. molle*.

9. HEDEOMA MOLLE Torr., Bot. U.S. Mex. Bound. Surv. 129. 1859.

Poliomintha mollis (Torr.) A. Gray, Proc. Am. Acad. 8: 365. 1872.

Robust, suffrutescent perennials or semi-shrubs, 16.0–55.0 cm (35.7 cm) high. Shoots numerous and long, ascending, tomentose-canescent or tomentulose-cinerous with short profusely branching hairs, arising from a woody caudex; branching almost completely confined to the basal region, the upper branches, when present, short and arising at close angles. Leaves narrowly to broadly elliptical to oval, highly variable, 3.0–10.0 mm (6.1 mm) wide, 8.5–22.0 mm (14.1 mm) long; margins entire or obscurely crenate; apex obtuse to somewhat acute; the base broadly or narrowly attenuated, petiolate, the petiole 0.5–4.0 mm (1.8 mm) long; surfaces evenly tomentose or tomentulose with intertangled, profusely branching hairs; nerves elevated. Axillary cymules 3–15-flowered (typically 10), occurring along the upper 1/3 of the stems, well-spaced or more commonly congested forming a dense but interrupted spike of cymes up to 7.0 cm long; primary peduncles prominent, 2.0–3.5 mm long, equal to or exceeding the length of the primary pedicel; pedicels 1.5–3.0 mm long, tomentose; bracteoles subulate as long as or longer than the pedicels they subtend. Calyx 5.2–7.0 mm (6.0 mm) long;

the tube nearly radially symmetrical, or slightly upwardly dilating, ca 1.1 mm wide in diameter, 4.2–6.0 mm long, occasionally slightly gibbous or curved (*Correll 30589* and *Hinckly & Warnock 46876,* respectively), tomentose with highly branched evenly distributed hairs; the calyx teeth only slightly differentiated into upper and lower sets; the upper calyx teeth connate for ca 1/3 of their length, the lobes subulate or very narrowly triangular, ca 0.7 mm wide at the base, 0.3–0.8 mm (0.5 mm) long, slightly laterally spreading or convergent, erect to sharply outwardly curling, the outer face and margins tomentose, the inner face covered with short pilose hairs as an extension of the prominent annulus; the lower teeth subulate, 0.3–0.5 mm wide, at the base, 0.6–1.3 mm (0.9 mm) long, clothed in a branched hair tomentum; annulus exserted, extremely dense, with unbranched, pilose hairs, ca 0.7 mm wide, seated approximately at the juncture of the poorly defined upper and lower lips. Corolla lavender 13.2–14.0 mm (13.6 mm) long, sparsely pubescent in the throat and in the lower tube but not forming a well-defined annulus; the tube and throat together 11.0–12.0 mm (11.5 mm) long conspicuously dilated upwardly, 3.0–3.5 mm wide above; the upper lip broadly ligulate, conspicuously emarginate, ca 1.9 wide, ca 2.2 mm long; the lower lip 4.0–5.0 mm wide, 3.0–4.0 long. Nutlets narrow, ca 0.3 mm wide, ca 1.2 mm long, the surface minutely areolate, and weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 3). Restricted to rock slopes and ledges of the Davis, Glass, Chisos, Chinati, and Sierra Vieja mountains of Trans-Pecos, Texas. 1,000–7,000 ft. Jul-Nov.

TYPE: TEXAS. Presidio Co., w of Alpine, cliffs near Puerta de Paysano, Sep. *Bigelow s.n.* (Holotype, NY! isotype, NY!).

Hedeoma molle occurs in widely separated populations; however, judging from its representation in herbaria, it is abundant where it occurs. Specimens from the northern portion of its range (Davis Mountains: Madera Canyon, *Cory 14042*; Ajuga Canyon, *Correll 33341*) are unusually large-leaved and show only a slight differentiation between the upper and lower calyx teeth. One specimen (*Correll 33341*) has gray-green leaves which measure 24.0 mm long and 16.0 mm wide. To the west, in the more arid Chinati Mountains, the leaves are quite diminutive, measuring ca 7.5 mm long and 2.5 mm wide, and there is a marked differentiation of the upper and lower calyx teeth. (*McVaugh 7453*).

H. molle is most closely related to *H. montanum.*

III. SUBGENUS **SATUREJOIDES,** Irving, subg. nov.

Herbae annuae vel perennes raro suffrutescentes, 5.0–60.0 cm altae; folia ovata, elliptica vel late elliptica, oblonga, lanceolata vel linearia, 3.0–28.0 mm longa, 1.0–16.0 mm lata, margine integra vel dentata, apice obtusa vel acuta, ad basin petiolata vel sessilia; cymulae 1–20-florae, remotae; calyx 4.0–10.0 mm longus, valde zygomorphus; calycis tubus leviter gibbosus vel saccatus; corolla varia (minuta vel longi tubularis vel magna conspicuaque), 5.5–20.0 mm longa; mericarpum oblongum,

duplo longiorum quam latiorum, brunneum (ad maturitatem), areolatum glaucum mucilaginum (in stat humectato); chromosomatum numerus, $2n = 34, 36, 44, 72$.

Herbaceous annuals or perennials, occasionally suffrutescent, 5.0–60.0 cm high. Shoots solitary to numerous, strict, ascending or decumbent, sometimes rhizomatous sending out adventitious roots from the lower nodes, arising from a taproot, trailing rootstock, or woody caudex. Leaves membranous, oval, linear, 3.0–28.0 mm long, 1.0–16.0 mm wide, margins entire to coarsely dentate, apex obtuse or acute, base subsessile to petiolate. Cymules 1–20-flowered, usually well-spaced along the stems, occasionally congested toward the apices forming a short "spike." Calyx zygomorphic; the tube slightly gibbous to saccate, 4.0–10.0 mm long, variable in pubescence; the calyx teeth well-differentiated into upper and lower sets; the upper teeth variously connate forming as upper lip; the lobes subulate, deltoid, variously ciliate, commonly spreading and reflexed; the lower teeth subulate and recurved, ciliate; annulus well developed. Corolla usually lavender-blue, variable from minute (*H. hispidum*) to long tubular (*H. costatum*) to large and showy (*H. pulcherrimum, H. diffusum,* and *H. hyssopifolium*), 5.5–45.0 mm long. Nutlets oblong or ovate in outline usually twice as long as wide, occasionally orbicular, brown at maturity, the surface areolate or foveate, glaucous and mucilaginous when moistened. Chromosome numbers, $2n = 34. 36, 44, 72$.

Type species: HEDEOMA COSTATUM Gray.

The subgenus *Saturjoides* is subdivided into two sections, *Alpine* and *Saturejoides*. It is the largest subgenus in *Hedeoma* and its species are reticulately related one to another.

The most homogeneous unit within the subgenus is the section *Alpine*. It is unified by a number of features. Section *Saturejoides*, on the other hand, is a more diversified group which presents greater difficulty in characterization and circumspection.

A. SECTION **ALPINE** Irving, sect. nov.

Herbae perennes 1.0–5.0 dm altae; surculi multi ascendentes vel decumbentes; folia elliptica vel oblonga vel oblanceolata margine integra apice obtusa, ad basin saepe subsessilia; calycis dentes superi longe connati, labium conspicuum facientes; mericarpium fere sphaeroideum vel ovoideum, diametro suo duplo longium vel breviora.

Perennial herbs 10.0–50.0 cm tall. Shoots few to numerous, ascending or decumbent and rhizomatous, sending out adventitious roots from the lower nodes, arising from a slender taproot. Leaves glandular, punctate on both surfaces, ovate, elliptical, oblong or oblanceolate, margins generally entire or obscurely serrate, apex obtuse, base typically tapered and subsessile. Cymules 3–7-flowered. Calyces variable between species, conspicuously zygomorphic, 4.0–8.0 mm long; the tube tubular or saccate; the upper teeth united to form a conspicuous upper lip, the lobes narrowly triangular or

deltoid; the lower teeth narrowly triangular or subulate, recurved. Corolla showy, 5.0–17.0 mm long, the upper lip obcordate, commonly reflexed, the lower lip various, spreading. Nutlets orbicular or ovate in outline, nearly spherical, ovoid, ovate in cross section, ca as long as wide, brown at maturity, the surface areolate. Chromosome number, $2n = 44$.

Type species: HEDEOMA PIPERITUM Benth.

A number of similarities, in addition to the morphic ones, unite the species of section *Alpine*: (1) they are found at the higher elevations; (2) they are the only representatives of the genus occurring in the Sierra Madre Occidental of Mexico and, except for the South American species, *H. polygalaefolium*, they are all found in this western range; (3) they all possess a chromosome number of $2n = 44$.

From these diverse lines of evidence, it is difficult to deny the naturalness of section *Alpine*. The weakest evidence for the groups naturalness comes from morphology, since the combination of characters which unite them are subtle.

10. HEDEOMA POLYGALAEFOLIUM Benth., Lab. Gen. et Sp. 367. 1834.

Small wiry perennial herbs, ca 10.0 cm high. Shoots decumbent and rhizomatous forming adventitious roots from the lower, buried nodes, branching freely along the axis; glabrate or with a few minute retrorsely curved hairs. Leaf pairs crowded with internodes uniformly ca 1.0 mm long. Leaves ascending, readily deciduous from the lower portions of the older stems, chartaceous becoming folded with drying, oblong to oblanceolate, 2.0–2.5 mm (2.3 mm) wide, 6.5–7.0 mm (6.8 mm) long, margins entire, apex obtuse, base narrowly attenuate and subsessile to a decurrent base; leaves glabrous throughout; nervation consisting solely of a prominent midrib. Cymules 1–3-flowered, congested toward the branch apices; peduncles 2.0–2.5 mm long; pedicels 4.5–5.0 mm long, puberulent with retrorsely curved hairs; bracteoles lanceolate shorter than the pedicels they subtend. Calyx conspicuously zygomorphic, ca 8.0 mm long; the tube tubular–funnelform, 4.5 mm long not at all gibbous below, dilating and flaring upwardly, ca 2.1 mm in diameter above, glabrous; the upper teeth united for ca 2/3 of their length forming an upper lip ca 2.5 mm long, pubescent within, the lobes narrowly triangular, acuminate at the apex, ca 0.5 mm wide at the base, ca 1.5 mm long, slightly spreading and reflexed, the margins glabrous; the lower teeth triangular–subulate, recurved, ca 3.0 mm long, hirtellous–ciliate; annulus dense ca 1.2 mm wide, seated ca 1.0 mm below the juncture of the upper and lower teeth but extended into the faces of the upper teeth, more or less included. Corolla ca 10.0 mm long. Nutlets 0.8 mm wide, ca 0.8 mm long, brown at maturity, the surface smooth and aerolate. Chromosome number, unknown.

Distribution (Fig. 12). Brazil, province Rio Grande do Sul.

TYPE: BRAZIL. 1841, *Sellow s.n.* (Holotype, K! isotype LA!: phototypes, LA! NY! PH! US!).

11. HEDEOMA BELLUM (Epl.) Irving, Brittonia 22: 345. 1970.

Hesperozygis bella Epl., Bull. Torr. Bot. Club 67: 512. 1940.

Small wiry perennial herbs, 15.0–30.0 cm in height. Shoots few to numerous, typically shortly decumbent (up to 7.0 cm) and rhizomatous sending out adventitious roots from the lower, buried nodes; sparsely branching; stems densely puberulent with the hairs spreading above and antrorsely curving below. Leaves spreading or cernuous, readily deciduous from the lower portions of the older stems, chartaceous, the margins often becoming revolute upon drying, oblanceolate-elliptical, 3.4–4.0 mm (3.6 mm) wide, 10.0–17.0 mm (15.0 mm) long, margins entire, apex obtuse, base gradually attenuate and subsessile; glabrous above, strigulose on the margins and midrib; nerves consisting of a prominent midrib and inconspicuous secondaries. Cymules 2–3-flowered, congested in the upper 1/4 of the stem forming a short terminal "spike", peduncles distinct but short, ca 1.5 mm long; pedicels 3.0–4.0 mm long, hirtellous with hairs spreading. Calyx conspicuously zygomorphic, ca 8.0 mm long; the tube ca 5.0 mm long not gibbous below, dilating upwardly, ca 2.5 mm wide above, sparsely hirtellous; upper teeth connate for approximately 2/3 of their length forming a conspicuous upper lip, ca 2.5 mm long, pubescent within with short pilose hairs, the lobes more or less deltoid or semi-ovate, conspicuously apiculate at the apex, ca 1.0 mm wide at the base, 1.0 mm long, sharply reflexed, strigulose-ciliate; the lower teeth sharply recurved, broadly triangular and tapering into a long aristate apex, ca 1.4 mm wide at the base, 3.4–3.8 mm long, hirsute–ciliate; annulus dense ca 1.0 mm wide, seated ca 1.0 mm below the upper lip, included. Corolla ca 12.0 mm long, pink and red dotted in the throat, minutely hirtellous within; the tube ca 10.0 mm long, gradually dilating upwardly; the upper lip obcordate, emarginate, straight or slightly reflexed, ca 2.0 mm long; the lower lip ca 5.0 mm broad, ca 3.0 mm long. Nutlets ca 0.8 mm wide, ca 0.8 mm long. Chromosome number, unknown.

Distribution (Fig. 4). *Hedeoma bellum* is known only from the type locality where, according to label data, it occurs on damp stream banks. Jan.

TYPE: JALISCO. Sierra Madre Occidental, San Sebastian, east of Arroyo Santa Gertrudis, 1500 m, 18 Jan 1927, *Mexia 1514* (Holotype, UC! isotypes F! NY!)

Vegetatively, especially in the leaves and in the inflorescence, *H. bellum* is similar to *H. patens*. It might also be noted that the common name of this species "oreganum", undoubtedly derived from its characteristic odor, is also the vernacular name given to *H. patens*. In the finer details of the calyx, one of the most elaborate in the genus *Hedeoma*, it is unique among the North American representatives, but is similar to the equally restricted South American species, *H. polygalaefolium*.

12. HEDEOMA JUCUNDUM Greene, Pitt., 1: 156. 1888.

Dense, caespitose perennial herbs, 10.0–15.0 cm in height. Shoots typically numerous, widely ascending or shortly decumbent; branched profusely at the base, and frequently producing adventitious roots from the lower

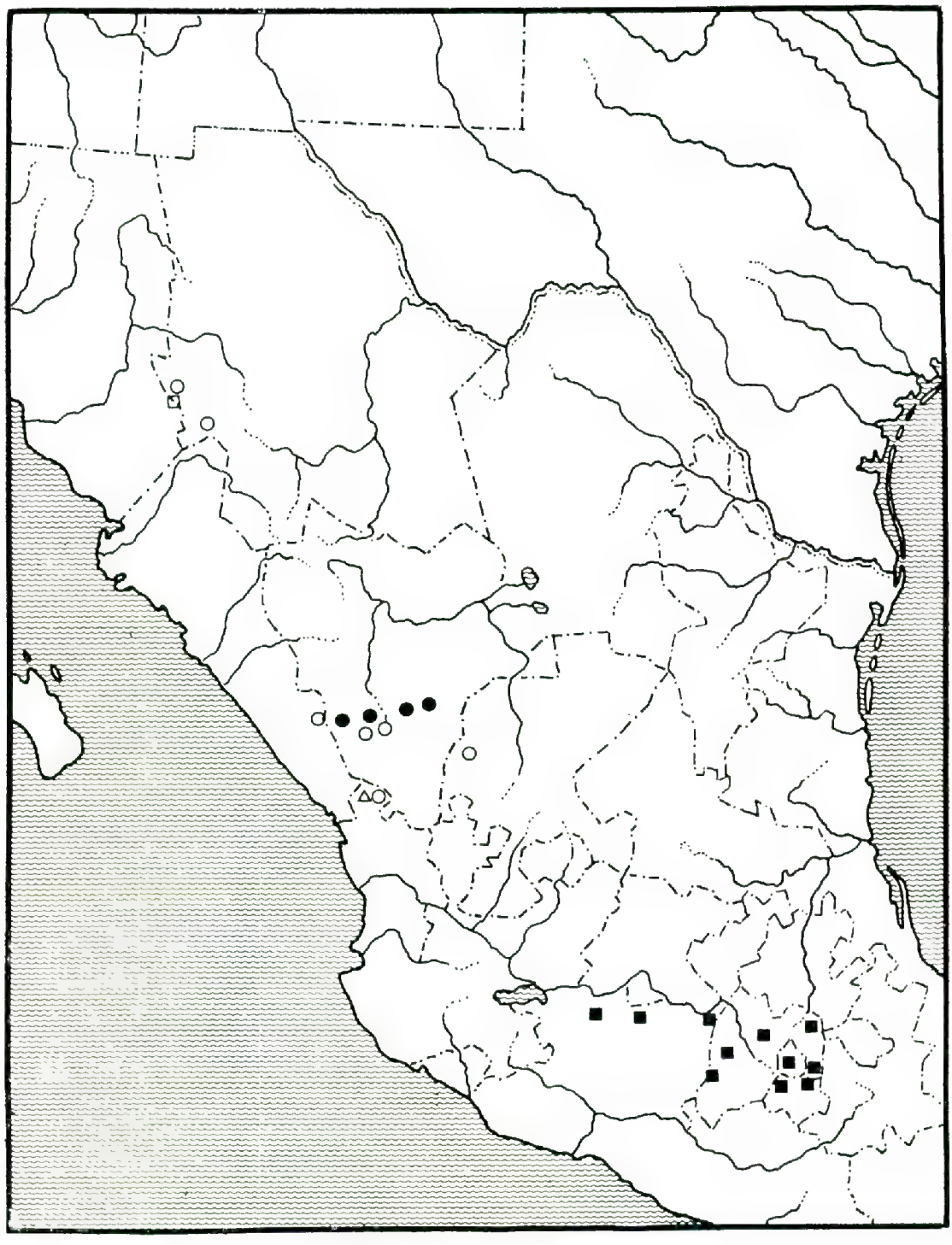


Fig. 4. Distribution of *Hedeoma patens* (open circles), *H. floribundum* (open square), *H. jucundum* (closed circles), *H. bellum* (open triangle) and *H. piperitum* (closed squares).

nodes, unbranched above or sparsely so; stems moderately to densely hirtellous above with retrorsely curving or occasionally spreading hairs, becoming puberulent below. Leaves spreading or ascending, chartaceous with the margins frequently becoming revolute upon drying, ovate to narrowly elliptical, 4.0–6.0 mm (5.3 mm) wide, 8.0–12.0 mm (11.0 mm) long, margins entire to obscurely serrate, apex obtuse, base shortly attenuate and subsessile; glabrous above, strigulose on the margins and the midrib below; nerves not conspicuously raised. Cymules 3–5-flowered, well-spaced along the upper 1/2 of the stems; peduncles inconspicuous less than 1.0 mm in length; pedicels 3.0–5.0 mm long, moderately hirtellous to puberulent. Calyx 6.0–7.0 mm (6.5 mm) long; the tube 3.5–4.5 mm (4.0 mm) long, slightly gibbous below for ca 1/2 of its length, the distended region ca 1.3 mm wide, dilating upwardly to ca 1.5 mm wide, sparsely to moderately hirsute-hirtellous; the upper calyx teeth connate for ca 1/2 of their length forming a pronounced, laterally rounded upper lip ca 2.3 mm long, the margins outwardly extended, the lobes triangular, ca 0.8 mm wide at the base, ca 1.2 mm long, sharply reflexed and laterally spreading, hirsute–ciliate; the lower teeth recurved, narrowly triangular–subulate, ca 8.0 mm wide at the base, ca 3.0 mm long, ciliate; the annulus dense ca 1.0 mm wide and arched upwardly into the connate portion of the upper lip, included. Corolla 11.0–12.0 mm (11.5 mm) long, white or pink with violet markings on the lower lip, glabrous within; the tube 9.0–10.0 mm long weakly dilating upwardly, ca 2.0 mm wide above; the upper lip obcordate in outline, ca 2.5 mm wide, 3.0 mm long, reflexed; the lower lip broad, ca 7.0 mm wide, ca 5.0 mm long. Nutlets ca 0.8 mm wide, 1.0 mm long, the surface minutely areolate, not glaucous. Chromosome number, $2n = 44$.

Distribution (Fig. 4). Sierra Madre Occidental, common in the pine forests west of the village of El Salto, Durango. 7000–9000 ft. Aug–Oct. TYPE: DURANGO. From the Sierra Madre, west of Durango, 8100 ft. Sep–Oct. 1881, *Forrer s.n.* (Holotype, ND! isotypes, F! GH! LA! NMC! NY! PH! POM! UC! US!).

Hedeoma jucundum is morphologically uniform and is most closely related to *H. piperitum.*

13. HEDEOMA PIPERITUM Benth., Lab. Gen. et Sp. 730. 1835.

Cunila piperita Moc. et Sesse ex Benth., Lab. Gen. et Sp. 730. 1835.

Loose, wiry, perennial herbs, somewhat caespitose, 10.0–20.0 cm tall. Shoots few to numerous, widely ascending or shortly decumbent; branching from the base, and frequently producing adventitious roots from the lower nodes, upper shoots typically unbranched or bearing a few short branches; stems densely hirsute with spreading hairs in the upper regions, hirtellous to puberulent below. Leaves spreading or drooping, membranous, broadly ovate to sub-orbicular, 5.0–13.0 mm (8.0 mm) wide, 7.0–18.0 mm (12.5 mm) long, margins entire or obscurely serrate, apex obtuse, base shortly attenuate

and subsessile; glabrous above, strigulose below on the nerves and margins; nerves not conspicuously raised. Cymules 3–7-flowered well-spaced along the upper 1/2 of the stems; peduncles inconspicuous less than 1.0 mm in length; pedicles 2.0–5.0 mm long, hirsute. Calyx strongly zygomorphic, 5.5–6.5 mm (6.0 mm) long; the tube 3.0–4.0 mm (3.5 mm) long, distinctly saccate below for ca 2/3 of the tube's length, the distended region 1.5–2.0 mm wide, sparsely to moderately hirsute; the upper calyx teeth united well over 1/2 of their length to form a reflexed, laterally rounded, upper lip ca 2.0 mm long, the margins outwardly flaring, hirtellous–ciliate, glabrous or pubescent on the inner face, the lobes semi-ovate to deltoid, ca 0.7 mm wide at the base, 0.7 mm long, ciliate; the lower teeth recurved, narrowly triangular, ca 0.8 mm wide at the base, ca 2.3 mm long, hirsute–ciliate; annulus moderately dense, ca 0.5 mm wide and arched somewhat into the upper lip, included. Corolla, 7.0–8.5 mm (8.0 mm) long, white with maroon markings on the lower lip, puberulent to glabrous within; the tube 5.5–7.0 mm (6.5 mm) long gradually dilated upwardly, the upper lip obcordate in outline, ca 2.3 wide, 1.5–2.0 mm long, straight or very slightly reflexed; the lower lip broad, 3.5–4.5 mm wide, ca 3.0 mm long. Nutlets 0.8 mm wide, ca 1.0 mm long, the surface minutely areolate, not glaucous. Chromosome number $2n = 44$.

Distribution (Fig. 4). Pine forests of central Mexico, 6,000–10,000 ft. Particularly abundant in sunny, open slopes associated with rocky lava or volcanic ash. Aug–Oct.

TYPE: MEXICO. Mocino et Sesse (lectotype, here designated BM!; isotypes, F! MA, photoisotypes, LA! TEX!). The specimen bearing the herbarium name *C. piperita* Moc. et Sesse was observed by Bentham in the Dunant herbarium which obtained the type from the herbarium of Pavon.

Hedeoma piperitum is quite distinct and relatively homogeneous throughout its narrow range. The salient morphological features which distinguish this species are its caespitose, broadly ovate-suborbicular leaves, and saccate calyx with its well-developed, expanded, upper lip. It is closely related to *H. jucundum*. Examination of the westernmost populations of *H. piperitum* (Cheron, Michoacan) reveal several subtle morphological departures from the eastern populations around Mexico City. The western populations vary in the direction of *H. jucundum*; that is, they have a more robust habit; thick, membraneous leaves (*Beal 4*); and retrorsely curling stem pubescence (*Beal 13*).

14. HEDEOMA PATENS Jones, Contrib. West. Bot. 12: 70. 1908.

Perennial herbs 20.0–55.0 cm high, averaging 30.0 cm. Shoots numerous, herbaceous above, decumbent (often one-sidedly so), woody below, branching freely, densely puberulent or hirtellous with hairs retrorsely curling. Leaves variable, laxly spreading to drooping, membranous, broadly to narrowly elliptical to oblanceolate, 2.0–8.0 mm (4.0 mm) wide, 5.0–22.0 mm (12.0

mm) long, margins entire or obscurely crenate, apex obtuse, base narrowly attenuate, short petiolate (seldom exceeding 1.5 mm) or subsessile; glabrous above, strigulose below and on the margins; nerves inconspicuous. Cymules well-spaced along the upper 2/3 of the stem with 3–7 flowers per cymule (typically 3–5), peduncles obscure to ca 2.0 mm long; pedicels 3.0–5.0 mm long, typically exceeding or equaling the length of the calyx tube, densely puberulent. Calyx 4.0–6.5 mm (6.0 mm) long, moderately zygomorphic; the tube 3.5–5.0 mm (4.0 mm) long, slightly gibbous below for 1/3–1/2 its length, the distended region 0.7–1.6 mm wide, puberulent to hirtellous with hairs strongly antrorsely curling; the upper calyx teeth connate for 1/3–1/4 of their length, forming a short upper lip 1.2 mm long, the lobes deltoid, ca 0.5 mm wide at the base, ca 0.5 mm long, laterally spreading, weakly reflexed, strigulose–ciliate; the lower calyx teeth recurved, subulate highly variable as to length, ca 0.5 mm wide at the base, 1.2–2.3 mm (1.8 mm) long, typically hirsute–ciliate; annulus dense, ca 0.5 mm wide, typically seated ca 0.5 mm below the juncture of the upper and lower teeth and included, occasionally exserted (*Knobloch 5407*). Corolla 7.0–9.0 mm (8.0 mm) long, pink, glabrous within; the tube 5.0–7.0 mm (6.0 mm) long, the throat scarcely dilated upwardly (ca 2.0 mm wide above); the upper lip obcordate in outline, ca 2.0 mm broad at the widest point, ca 2.6 mm long, reflexed; the lower lip, ca 5.0 mm wide, ca 4.5 mm long. Nutlets not quite twice as long as broad, 0.5 mm wide, ca 0.9 mm long, the surface minutely areolate, and weakly glaucous. Chromosome number $2n = 44$.

Distribution (Fig. 4). Pine forests of the Sierra Madre Occidental. 5000–7000 ft. Aug–Oct.

TYPE: CHIHUAHUA. Sierra Madre Mts., "Guayanopa Canyon", 5000 ft., 23 Sep 1903, *Jones s.n.* (Holotype, POM! phototype, LA!).

Hedeoma patens is an exceedingly variable species. The specimens which I have examined seem to form a transition between *H. hyssopifolium* and *H. pulcherrimum* (SECTION Saturejoides), and *H. jucundum* and *H. piperitum* (SECTION *Alpine*).

Epling and Stewart (1939) placed *H. patens* close to *H. pulcherrimum.* Admittedly, they resemble each other in many respects, particularly in habit and vegetative morphology. They can be readily separated from each other, however, by the important details of the calyx and corolla.

15. HEDEOMA FLORIBUNDUM Standley, Rep. Spec. Nov., Beihefte 115: 31. 1939.

Perennial herbs 20.0–32.0 cm high. Shoots woody below, ascending or decumbent, branching freely along the axis with the branches ascending at close angles, clothed below in long spreading pubescence, above puberulent with hairs tightly retrorsely curling. Leaves laxly spreading to cernuous, membranous, narrowly elliptical or oblanceolate, 4.0–5.0 mm (4.7 mm) wide, 15.0–18.5 mm (15.9 mm) long, margins entire or obscurely crenate,

apex obtuse, base narrowly petiolate with the petiole ca 1.0 mm long; glabrate above, puberulent below; nerves inconspicuous. Cymules aggregated toward the branch apices forming a short terminal spike, ca 4.0 cm long, 3–7-flowered (typically 3–5), peduncles and pedicels contorted; peduncles inconspicuous to ca 1.0 mm long; pedicels 2.0–2.5 mm long, shorter than the calyx tube, puberulent. Calyx 3.0–3.5 mm long, weakly zygomorphic; puberlulent with antrorsely curling hairs, the tube 2.5–3.0 mm long. The tube weakly distended ca 1.0 mm wide; the upper and lower teeth only slightly differentiated; the upper teeth united for ca 1/3 of their length forming an upper lip ca 0.5 mm long, the lobes erect, deltoid ca 0.4 mm wide at the base, ca 0.4 m long; the lower teeth ca 0.5 mm wide at the base, 0.5 mm long; annulus included, ca 0.5 mm wide and seated just below the juncture of the upper and lower lips. Corolla 5.0–6.0 mm long, glabrous within; the tube 4.0–5.0 mm long gradually widening upwardly, upper lip obcordate, 1.0–1.2 mm wide, 1.0–1.5 mm long; the lower lip ca 2.5 mm wide, 2.5 mm long. Nutlets 0.5 mm wide, 0.9 mm long, the surface minutely areolate, glaucous. Chromosome number, unknown.

Distribution (Fig. 4). Pine forests along the Rio Mayo in the state of Chihuahua, Mexico. Oct.

TYPE: CHIHUAHUA. Cerro Quicorichi, Rio Mayo, 6 Oct 1935, *Gentry 1938* (Holotype, F!; isotype, LA!).

The vegetative features of *H. floribundum* are similar to those of *H. patens*, and they have similar distributions. The salient differences between these two species reside in the inflorescence and calyx. Unlike *H. patens*, the inflorescence of *H. floribundum* is a dense terminal spike and the calyx shows a greater trend toward radical symmetry, both in the tube and in the disposition of its teeth.

B. SECTION **SATUREJOIDES**, Irving, sect. nov.

Herbae annuae vel perennes, raro suffrutescentes, 5.0–60.0 cm altae; folia varia, margine integra vel saepe serrata vel dentata, ad basin petiolata vel subsessilia; cymulae 1–20 florae; calyx 4.0–10.0 mm longus, gibbosus vel saccatus; calycis dentes superi ad medium connati, lobi subulati vel anguste triangulares; corolla inconspicua vel magna conspicuaque, 5.5–20.0 mm longa; mericarpium oblongum, circa duplo longiorum quam latiorum brunneum (ad maturitatem), areolatum vel foveolatum.

Herbaceous annuals or perennials, occasionally suffrutescent and woody below, 5.0–60.0 cm high. Shoots solitary to numerous ascending or decumbent, occasionally rhizomatous and forming adventitious roots. Leaves glandular punctate, variously shaped. Margins entire, serrate, or dentate, apex acute or narrowly obtuse, base petiolate or subsessile. Cymules 1–20-flowered. Calyx 4.0–10.0 mm long, zygomorphic; the tube slightly gibbous to distinctly saccate; the upper teeth variously connate, the lobes subulate or narrowly triangular; the lower teeth subulate and recurved; both upper and lower teeth variously ciliate. Corollas inconspicuous to large and showy, 5.5–45.0 mm long; the upper lip ligulate, straight or reflexed, flat or sub-galeate;

the lower lip spreading. Nutlets oblong, at least twice as long as wide, ovate-triangular in cross section, brown at maturity, the surface areolate or foveate, glaucous. Chromosome numbers, $2n = 34, 36, 72$.

TYPE: HEDEOMA COSTATUM Gray.

16. HEDEOMA PULCHERRIMUM Woot. & Standl., Contr. U.S. Natl. Herb. 16: 168. 1913.

Robust, perennial herbs, 15.0–40.0 cm in height (typically between 20.0 and 30.0 cm). Shoots few to numerous, ascending or very shortly decumbent, woody below, herbaceous above; branching frequently in the lower half, the branches long and widely ascending, stems below clothed in villous pubescence, above sparsely to densely puberulent with the hairs tightly retrorsely curling. Leaves thick membranous, elliptical–oblong, 8.0–18.0 mm (13.4 mm) long, 2.0–6.5 mm (4.2 mm) wide, margins entire to obscurely serrate, base attenuated, short petiolate or subsessile, apex obtuse; leaves glabrous above, strigulose below and on margins; nerves conspicuous. Cymules well-spaced along the upper 2/3 of the stems with 3–7 flowers per cymule (typically 3–5); peduncles short; 1.0–2.0 mm long; pedicels 2.0–3.5 mm long, minutely puberulent; bracteoles short. Calyx 6.0–7.0 mm (6.6 mm) long; the tube 3.0–5.0 mm (4.0 mm) long, slightly gibbous below for ca 1/2 of the tube's length, the distended region ca 1.2 mm wide, typically moderately hirsute; the upper calyx teeth connate for 1/3–1/4 of their length forming an upper lip, 1.5–2.0 mm long, the lobes very narrowly triangulate-lanceolate (nearly subulate), ca 0.3 mm wide at the base, ca 1.7 mm long, laterally spreading and reflexed (with maturity becoming erect and convergent with the lower teeth), hirsute or hirtellous–ciliate; the lower calyx teeth recurved, subulate, ca 0.5 mm wide at the base, ca 2.7 mm long; annulus dense, ca 1.0 mm wide, seated at the juncture of the upper and lower teeth, exserted. Corolla 10.0–14.0 mm (12.4 mm) long, blue, sparsely villous within the throat and densely short pubescent in the tube forming a well-defined annulus, 2.0–3.0 mm in width; the tube 8.0–10.0 mm (9.0 mm) long, the throat strongly dilated, ca 5.0 mm wide; the upper lip broadly ligulate, slightly emarginate, 3.0–3.3 mm broad, 3.0–4.0 mm long, straight (not upwardly reflexed); the lower lip broad ca 7.0 mm wide, ca 5.0 mm long. Nutlets ca 0.6 mm wide, 1.2 mm long, the surface minutely areolate, weakly glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 5). Restricted to the Sacramento and White Mountains of south central New Mexico where it is common in Pine or Spruce-Fir forests, especially in disturbed areas; 5000–9000 ft. Jul–Sept.

TYPE: NEW MEXICO. Lincoln Co., collected in the White Mountains, 6500 ft., 30 July 1897, *Wooton 241* (Holotype, US! isotypes, DS!, LA! ND! NMC! NY! POM! UC! US!).

H. pulcherrimum has been difficult taxonomically to place. In the original description, Wooton and Standley state: "This species [*H. pulcherrimum*] seems to be on the dividing line between the two principal groups of species:

its upper calyx lobes are not foliaceous expanded as in one group [Sect. Alpine] nor narrowly subulate as in the other but are triangulate-lanceolate and hispid-ciliate like those of the second group [Sect. *Saturejoides*]". Although recognizing its transitional nature, they thought it closest to *H. jucundum*. Epling and Stewart however, aligned *H. pulcherrimum* with *H. patens*.

I have treated *H. pulcherrimum* as being most closely related to *H. drummondii*. Except for characters of the calyx, the western elements of the *H. drummondii* complex are identical, or nearly so, to *H. pulcherrimum*. Moreover, natural hybridization occasionally occurs between these species with the F_1 hybrids vigorous and partially fertile (ca 20%).

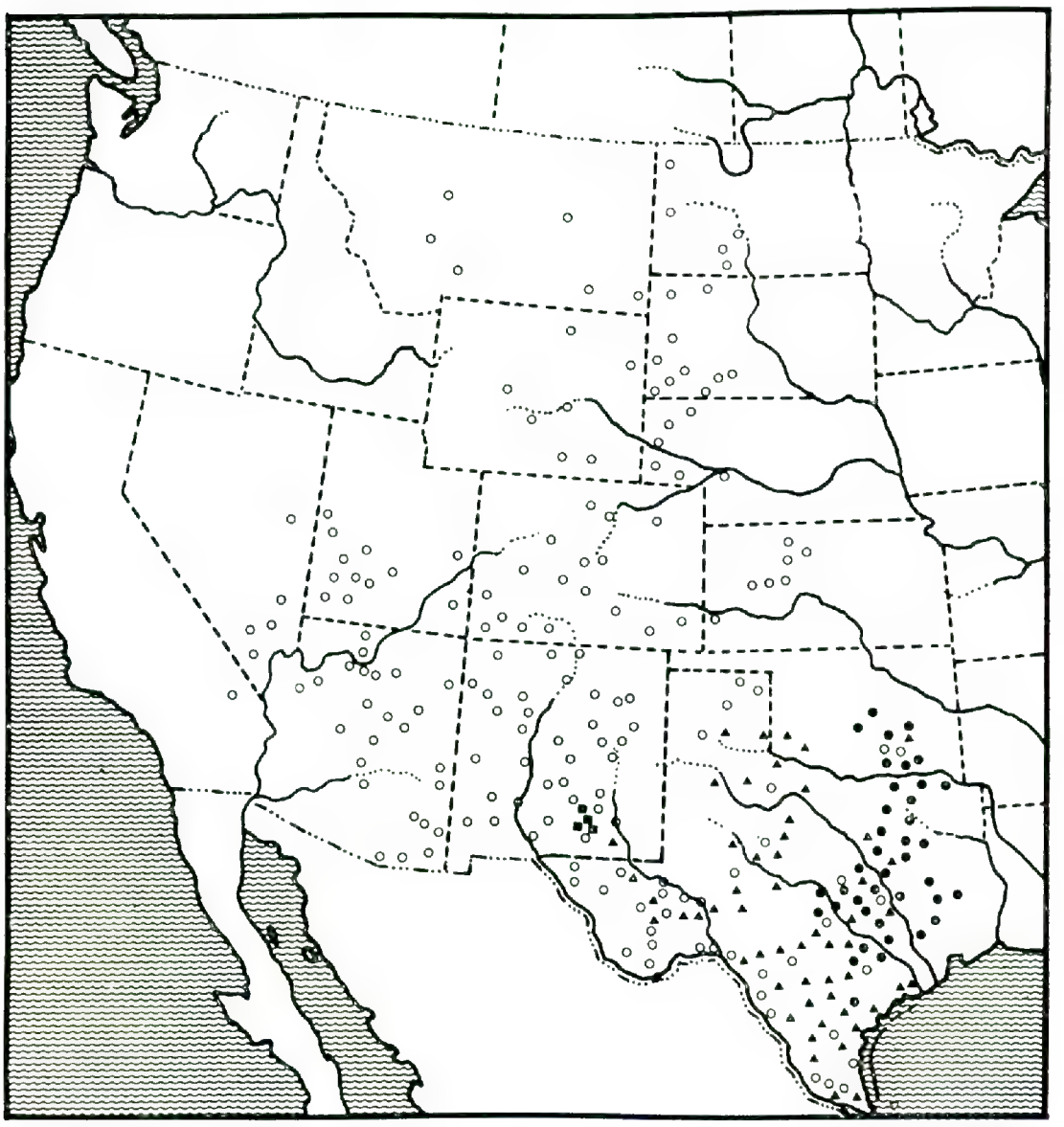


Fig. 5. United States distribution of *Hedeoma pulcherrimum* (squares), *H. drummondii* (open circles), *H. reverchonii* var. *serpyllifolium* (triangles), and *H.r.* var. *reverchonii* (closed circles).

17. HEDEOMA DRUMMONDII Benth. Lab. Gen. et Sp. 368. 1836.

Hedeoma ciliatum Nutt., Journ. Acad. Nat. Sci. Phil., N.S. 1: 183. 1847.
TYPE: NEW MEXICO: Santa Fe Co., Santa Fe, *Gambel s.n.* (Lectotype, GH! isotype, K!)

Hedeoma ovatum A. Nels., Bull. Torr. Bot. Club 31: 245. 1904.
TYPE: WYOMING. Pole Creek, 30 Jun 1895, *Nelson 1374* (Holotype, RM!; isotype, GH!)

Hedeoma longiflorum Rydb., Bull. Torr. Bot. Club 36: 695. 1909.
TYPE: NEBRASKA. Banner Co., Cliffs of Canyons, Aug 1890, *Rydberg x297* (Holotype, NY!)

Hedeoma camporum Rydb., Flora Rocky Mts. 750. 1917.
Based on *H. longiflorum*.

Hedeoma drummondii Benth. var. *crenulatum* Irving, Britt. 22: 342. 1970.
TYPE: MEXICO, San Luis Potosi, 7.8 mi w of Guadalcazar, 10 Aug 1965, *Irving 632* (Holotype, TEX!; isotype, MONTU!)

Annuals or robust perennials, 15.0–45.0 cm high. Shoots few to numerous, shortly decumbent and/or frequently spreading upwardly at wide angles, branching freely along the lower 1/2 to 2/3 of the stems with the branches typically long, straight, and spreading at angles of ca 45°; stems densely pubescent or puberulent above with the hairs tightly retrorsely curling, glabrate below. Leaves bright green, cernuous, thick membranous, linear to elliptic-oblong, 1.2–4.0 mm (2.2 mm) wide, 5.0–11.0 mm (7.7 mm) long, entire, obtuse at apex, narrowly attenuated and short petiolate or subsessile, glabrous or sparsely pubescent above, densely pubescent below; nerves inconspicuous. Cymules somewhat crowded along the upper 1/2–3/4 of the stems with 3–7 flowers/cymule; peduncles inconspicuous to ca 1.5 mm long; pedicels 2.0–3.5 mm long, pubescent; bracteoles subulate ca 1/2 as long as pedicels. Calyx finely hirsute, 5.0–6.0 mm (5.6 mm) long, conspicuously saccate for ca 2/3 of its length, the distended region 1.2–1.3 mm wide; the tube tapering to a slender neck ca 0.5 mm wide closing the orifice after anthesis; the upper calyx teeth slightly connate, subulate or very narrowly triangular, ca 0.2 mm wide at the base, 1.0–1.5 mm long, erect and dorsiventrally convergent with the lower teeth to close the orifice, hirsute-ciliate; the lower teeth subulate, recurved and arching over the upper teeth, 0.3 wide at the base, 1.5–2.0 mm long, ciliate; annulus dense ca 1.5 mm wide and seated ca 1.5 mm below the juncture of the upper and lower teeth. Corolla blue, 7.0–9.0 mm (8.0 mm) long sparsely pubescent in the throat, densely to below forming an annulus 0.7–1.5 mm wide; the tube 1.0 mm wide; the upper lip ligulate 1.0–1.5 mm long; the lower lip 2.5–3.0 mm wide and 2.5–3.0 mm long. Nutlets ca 0.4 mm wide, ca 1.2 mm long. Chromosome numbers, $2n = 34, 36$.

Distribution (Fig. 5). Various habitats from Montana to San Luis Potosi, Mexico; and western California to western Nebraska. Jun–Sep.

TYPE: NUEVO LEON. Near Monterrey, 1828, *Berlandier s.n.* (Holotype, K!; isotypes, BM! GH!).

H. drummondii is a morphologically variable species and a number of

races can be discerned within it. In central Texas along the escarpment of the Edwards Plateau the plants take the form of annuals or biennials with linear leaves, sparsely pubescent calyx, and the teeth strongly converging. Many of these populations are aneuploid ($2n = 34$) and hybridize with both varieties of *H. reverchonii*. Towards the west and north, the plants take the form of tufted caespitose perennials with leaves more oblong-elliptic and the calyx to varying degrees sealed at the summit. In southern Nevada hybridization with *H. nanum* produces still another morphological grouping. To the west, mesic montane forms possess long cernuous elliptical-oblong leaves and calyx teeth only very loosely closed at the summit. This last form is common in the Guadalupe Mountains of west Texas and in the Sacramento Mountains of central New Mexico where it hybridizes with *H. pulcherrimum*. The eastern Mexico populations, occurring along the eastern edge of the Sierra Madre Oriental, vary in the direction of *H. reverchonii* var. *serpyllifolium*.

18. HEDEOMA REVERCHONII Gray

Key to the varieties of *H. reverchonii*

1. Plants 25.0–60.0 cm tall branching usually restricted to the base and the upper 1/2 of the shoots; leaves gray green, ca 3.7 mm wide, 11.7 mm long; calyx 6.0–7.0 mm long, very coarsely hirsute to hoary pilose; the upper teeth widely spreading; corolla large, 10.0–15.0 mm long, the tube conspicuously dilated upwardly; plants restricted to the eastern edge of the Edwards Plateau and Lampasas Cut Plain of central Texas, and south central Oklahoma; lemon-scented in typical forms. ..... 18a. *H.r.* var. *reverchonii*
1. Plants 15.0–40.0 cm tall branching freely along the lower 2/3 of the shoots; leaves dark green, ca 3.0 mm wide, 8.3 mm long; calyx 5.0–6.0 mm long, coarsely hirsute, the upper teeth erect or only slightly spreading laterally; corolla small, 8.0–10.0 mm long, the tube only very slightly dilated upwardly; plants from eastern edge of Edwards Plateau south to the Central Coastal Plain of Texas and west to southeastern New Mexico; camphor-scented ..... 18b. *H.r.* var. *serpyllifolium*

18a. HEDEOMA REVERCHONII Gray var. REVERCHONII, Syn. Fl. ed 2, 2: 460. 1886.

Hedeoma drummondii var. *reverchonii* A. Gray, Syn. Fl. 2: 363, 1878.
Hedeoma latum Small, Fl. S.E. U.S. 1040, 1337, 1903. TYPE: TEXAS. Dallas Co. Rocky prairies, near Dallas, Texas, Jun–Sept. *Reverchon (Curtis 2020)* (Holotype, NY! isotypes, BM! F! GH! ND! NY! SMU! US!)

Robust, suffruticose perennials, 25.0–60.0 cm high, with the shoots of the previous season usually persistent. Shoots ascending or shortly decumbent, arising from a stout woody taproot, branching more or less restricted to the very base, branches long and well-developed; stems densely pubescence, nearly canescent above with tightly retrorsely curling hairs, glabrous below. Leaves gray-green, usually erect, coriaceous, elliptic-oblong and highly variable in size, 3.0–5.0 mm (3.7 mm) wide, 9.0–14.0 mm (11.7 mm) long, margins entire, apex obtuse, base narrowly attenuated and subsessile, sparsely pubescent above, densely so below and on the margins; nerves inconspicuous.

Cymules 2–4-flowered (occasionally more) well-spaced along the upper 1/2 of the stems; peduncles 1.0–1.5 mm long; pedicels 3.0–4.0 mm long, clothed in tightly retrorsely curling hairs, bracteoles short. Calyx 6.0–8.0 mm (6.6 mm) long; the tube 4.0–5.5 mm (4.2) long, saccate below tapering to a narrow neck partially sealing the calyx orifice, hoary villous with the hairs antrorsely curling at their tips and up to 1.5 mm long; the upper calyx teeth not connate or slightly so, the lobes subulate, ca 0.2 mm wide at the base and ca 1.0 mm long, laterally spreading, slightly reflexed but with the base convergent to the lower teeth and closing the orifice, hirsute–ciliate; the lower teeth subulate, recurved 2.0–2.5 mm long, ciliate; annulus extremely dense ca 1.5 mm wide and seated ca 1.5 mm below the juncture of the upper and lower teeth. Corolla large and showy 10.0–15.0 mm (12.0 mm) long, white or lavender, variously marked on the throat, sparsely pubescent in the throat, densely so in the tube forming a well-defined annulus; the tube dilating distally to ca 5.0 mm wide above; the upper lip ligulate and sub-galeate, ca 5.0 wide at the base, 4.0–5.0 mm long, the lower lip ca 4.0–5.0 mm wide, ca 5.0 mm long. Nutlets ca 0.6 mm wide, ca 1.2 mm long, areolate and glaucous. Chromosome number, $2n = 34$.

Distribution (Fig. 5). Open, exposed, calcareous outcrops in southern Oklahoma and central Texas along the fault escarpements of the Edwards Plateau and Lampasas Cut Plain. Also collected infrequently on calcareous outcrops in east Texas, Arkansas and Alabama, as yet however, it is unreported in Louisiana and Mississippi.

TYPE: TEXAS. Brown Co., Rocks, Blanket, 9 Aug 1877, *Reverchon 755* (Holotype, GH!; isotypes, F! NY! US!).

18b. HEDEOMA REVERCHONII Gray var. SERPYLLIFOLIUM (Small) Irving, Britt. 22: 333-345. 1970.

Hedeoma serpyllifolium Small, Bull. N.Y. Bot. Gard. 1: 287. 1896.
Hedeoma sanctum Small, Bull. N.Y. Bot. Gard. 1: 287. 1896. TYPE: TEXAS. Bexar Co., San Antonio, Apr 1853, *Thurber s.n.* (Holotype, NY!; isotype, GH!).

Robust, suffruticose perennials, 15.0–40.0 cm high, the shoots of the previous season persistent. Shoots numerous, ascending or decumbent, branching freely along the lower 2/3 of the stems, the branches long and ascending, densely pubescent above with retrorsely curling hairs, puberulent below. Leaves dark green typically falling from the lower 1/2 of the shoots with maturity, ascending, thick membranous, elliptical-oblong, 2.2–4.0 mm (3.0 mm) wide, 6.0–10.0 mm (8.3 mm) long, margins entire, apex obtuse, base narrowly attenuated, petiolate or subsessile, glabrate above, densely pubescent below; nerves inconspicuous. Cymules usually 2–4-flowered, somewhat crowded along the upper 2/3 of the stems, developing to one-side; peduncles 1.0–1.5 mm long; pedicels 2.0–3.0 mm long clothed in retrorsely curling puberulent hairs, bracteoles short. Calyx 5.0–6.0 mm (5.5 mm) long; the tube saccate below tapering distally and partially closing the tube,

3.0–4.0 mm (3.7 mm) long, densely hirsute pubescent with the hairs spreading or antrorsely curved; the upper calyx teeth slightly connate, subulate, ca 0.2 mm wide at the base, 1.0–1.2 mm long, erect or slightly laterally spreading, somewhat convergent with the lower and closing the orifice, hirsute-ciliate; the lower teeth subulate ca 0.2 mm wide at the base, 1.5–2.0 mm long; annulus very dense, ca 1.5 mm wide and seated ca 1.5 mm below the juncture of the upper and lower teeth. Corolla chiefly white, occasionally lavender, 8.0–10.0 mm (9.0 mm) long, sparsely pubescent in the throat, densely so below forming an annulus; the tube dilating upwardly to ca 2.0 mm wide; the upper lip ligulate ca 1.0 wide at the base, ca 1.5 mm long; the lower lip ca 3.2 mm wide, 3.2 mm long. Nutlets ca 0.5 mm wide, ca 1.2 mm long, areolate and glaucous. Chromosome number, $2n = 34$.

Distribution (Fig. 5). Abundant in open calcareous outcrops and roadcuts from the Balcones fault escarpment of central Texas to southeastern New Mexico and southward into the south Texas Coastal Plain. Jun–Sep.

TYPE: TEXAS. Kerr Co., Kerrville, 1600–2000 ft., 25–30 Apr 1894, *Heller 1663* (Holotypes, NY! isotypes, GH! IA! MICH! MCS! ND! NY! PH! SMU! UC! US!).

19. HEDEOMA MULTIFLORUM Benth., Lab., Gen. et Sp. 367. 1834.

Hedeoma gilliesii Benth., Lab. Gen. et Sp., 367. 1834. TYPE: ARGENTINA. Cerro de Archiras near Mendosa, 1820, *Gillies s.n.* (Holotype, K!; isotype, LA!; phototypes LA! NY! PH!).

Micromeria bonariensis Fisch. et Meyer, Ind. Sem. Hort. Petrop. X: 56. 1845. TYPE: not located.

Satureia gilliesii (Benth.) Briq., in Engler & Prantl. Nat. Pflanzanf. ed. 1, IV, 3a, 300. 1897. Based on *Hedeoma gilliesii* Benth.

Satureia bonariensis (Fisch. et Meyer) Briq., in Engler & Prantl. Nat. Pflanzanf. ed. 1, IV, 3a, 300. 1897. Based on *Micromeria bonariensis* Fisch. et Meyer.

Robust, caespitose perennials forming tufts, 5.0–25.0 cm in height. Shoots numerous densely pubescent or puberulent with retrorsely curling hairs on the upper herbaceous portions of the stems, becoming glabrate below on the lower woody portions, branching mostly confined to the lower half, the branches widely ascending to nearly 45° angles. Leaves deciduous from the lower stem regions with maturity, spreading, membranous, linear-lanceolate, usually five times longer than wide, 1.0–1.5 mm (1.2 mm) wide, 5.5–8.5 mm (7.1 mm) long, margins entire, apex acutish, base narrowly attenuated and subsessile, upper and lower leaf surfaces and margins strigose; nerves indistinct. Axillary leaf buds develop on the immature stems yielding 2–3 leaf pairs. Cymules 1–5-flowered (commonly 1–2-flowered), well-spaced along almost the entire length of the shoots; peduncles inconspicuous, less than 0.5 mm long, pedicels 3.0–4.0 mm long, retrosely puberulent; bracteoles lanceloate, typically shorter than the pedicels they subtend. Calyx 5.0–6.0 mm (5.8 mm) long; the tube 3.9–4.5 mm (4.1 mm) long conspicuously saccate for ca 2/3 of its length, the distended region 1.2–1.5 mm wide,

the tube above the pouch constricted and tapered into a narrow upper neck, 0.8–1.0 mm wide, partially closing the calyx orifice; calyx sparsely and minutely hirtellous with antrorsely curling hairs; the upper calyx teeth connate for 1/3–1/2 of their length forming an upper lip, 0.8–1.2 mm long, pubescent on its inner face, the lobes narrowly triangular, spreading and slightly reflexed, ca 0.3 mm wide at the base, 0.4–0.8 mm long, hirtellous-ciliate; the lower teeth subulate, 1.5–2.0 mm long; annulus dense, ca 0.7 mm wide and seated ca 1.0 mm below the juncture of the upper and lower teeth, extended upwardly into the inner face of the upper lip, included. Corolla ca 8.2 mm long, glabrous within; the tube ca 7.0 mm long gradually dilated upwardly, ca 2.0 mm wide; the upper lip ligulate, emarginate, 1.0–1.2 mm wide, ca 2.0 mm long; the lower lip ca 3.5 mm wide, ca 3.0 mm long. Nutlets ca 0.7 mm wide, 1.4 mm long, the surface foveate, brown at maturity, strongly glaucous. Chromosome number, $2n = 72$.

Distribution (Fig. 12). Rocky calcareous outcrops of rivers and roadcuts in southern Brazil, Uruguay, and northern Argentina. Nov–Feb.

TYPE: BRAZIL. 1830, *Sello 1062* (Holotype, B destroyed; lectotypes here designated K! isotypes LA!; photolectotypes, LA! NY! PH!).

Hedeoma multiflorum is most closely allied to *H. drummondii* of the Northern Hemisphere and differs from it primarily in the details of the calyx.

20. HEDEOMA DIFFUSUM Greene, Pittonia 3: 338. 1898.

Hedeoma blepharodontum Greene, Pitt. 3: 339. 1898. TYPE: ARIZONA. Coconino Co. near Flagstaff, 29 Aug 1884, *Jones 404* or *4104* (Holotype, US! isotypes, BM! CAS! DS! GH! LA! MCS! NY! POM! UC! US!)

Perennial herbs forming dense, circular, dwarfed mats with numerous decumbent shoots, 7.0–20.0 cm long; branching prolifically at the base and generally unbranched distally, stems puberulent above with retrorsely curling or spreading hairs, pubescent with spreading hairs below. Leaves spreading, membranous, ovate, 2.0–4.5 mm (3.0 mm) wide, 3.5–0.0 mm (5.2 mm) long, margins entire, apex narrowly obtuse or acute, base rounded or attenuated and petiolate, petioles 5.0–1.0 mm long; the blade glabrate or puberulent above, densely hirtellous-puberulent below and on the margins; nervation inconspicuous. Cymules 1–3-flowered, occurring well-spaced along nearly the full length of the numerous shoots; peduncles 0.5–1.0 mm long; pedicels 2.0–3.0 mm long puberulent with retrorsely curving hairs; bracteoles subulate, shorter than the pedicels they subtend. Calyx 5.0–6.0 mm (5.3 mm) long; the tube 3.0–4.0 mm (3.6 mm) long more or less tubular, slightly gibbous below, the distended portion ca 1.0 mm wide dilated upwardly, hirtellous-hirsute with spreading hairs; the upper calyx teeth united for ca 1/3 of their length or less, forming an upper lip 1.0–1.2 mm long, pubescent on its inner face, the lobes narrowly triangular, 0.6–1.3 mm long, laterally spreading and reflexed or erect, hirsute-ciliate; the lower teeth

subulate, recurved, 1.5–2.0 mm long, hirsute-ciliate; annulus dense, included or slightly exserted, 0.5–1.0 mm wide seated just below the juncture of the upper and lower teeth. Corolla ca. 9.5 mm long, blue, pubescent within on the throat, annulate below; the tube ca 7.5 mm long upwardly inflated, ca 2.5 mm wide above; the upper lip ligulate, subgaleate, and straight but with the margins and apex revolute, ca 2.3 mm wide, ca 2.0 mm long, emarginate; the lower lip ca 5.0 mm wide, ca 5.0 mm long. Nutlets ca 0.5 mm wide, 1.1 mm long, the surface areolate and strongly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 6). Pine forests in the vicinity of Flagstaff, Arizona; common on rocky outcrops and exposed areas, ca 7000 ft. Jul–Sep.

TYPE: ARIZONA. Coconino Co. near Flagstaff, 1883. *Rusby 786.* (Holotype, GH! isotypes, LA! MICH! NY! PH! UC! US!).

Although I accept the name and type of *H. diffusum* designated by Greene, I cannot accept his morphological concept of the species. From his discussion Greene apparently had a broad concept of this taxon. As he indicated, the range of the species was "from north to south throughout the state [Arizona]". Thus, the distribution would extend into the range of *H. nanum*. *H. diffusum*, as it is realized here, is restricted to the *Pinus ponderosa* forest of the Flagstaff area. This distribution also concurs with that accorded *H. diffusum* by Epling and Stewart (1939).

Hedeoma diffusum is most closely related to *H. nanum*. The ovate, entire, acute leaves, gibbous calyx, and the ad- and abaxially inflated corolla are all common morphological features.

21. HEDEOMA NANUM (Torr.) Briq.

Key to the varieties of *Hedeoma nanum*.

1. Coarse, robust perennials with shoots few to numerous; leaves 5.0–16.0 mm wide, 8.0–25.0 mm long; cymules 1–7-flowered and well-spaced along the axis; calyces large, 6.0–8.0 mm long, slightly gibbous or saccate below; plants of central and western Arizona. ..... 21c. *H.n.* var. *macrocalyx*
1. Plants not as above.
   2. Caespitose perennials forming dense tufts with shoots extremely numerous, retrorsely puberulent-pubescent; leaves 2.1–4.5 mm wide, 3.5–6.5 mm long; cymules 3–5-flowered, well-space along the axis; calyces 4.5–5.6 mm long, weakly saccate below; plants confined to southern-most Nevada and contiguous areas in California and Arizona. ..... 21b. *H.n.* var. *californicum*
   2. Annual or perennial herbs of various habits, shoots solitary to numerous, pubescence spreading or retrorsely curving, pilose or hirsute; leaves 2.6–6.0 mm wide, 5.5–13.0 mm long, cymules 3–15-flowered (tpically 8–10) well-spaced or congested, forming a dense "spike"; calyces 4.0–5.2 mm long, distinctly saccate; plants widespread–Arizona, New Mexico, Texas and Mexico. ..... 21a. *H.n.* var. *nanum*

21a. HEDEOMA NANUM (Torr.) Briq. var. NANUM, in Engler & Prantl, Die Naturlichen Pfl. IX, 3a, 294. 1897.

Hedeoma dentatum var. *nanum* Torr., Bot. Mex. Bound. 130. 1859.

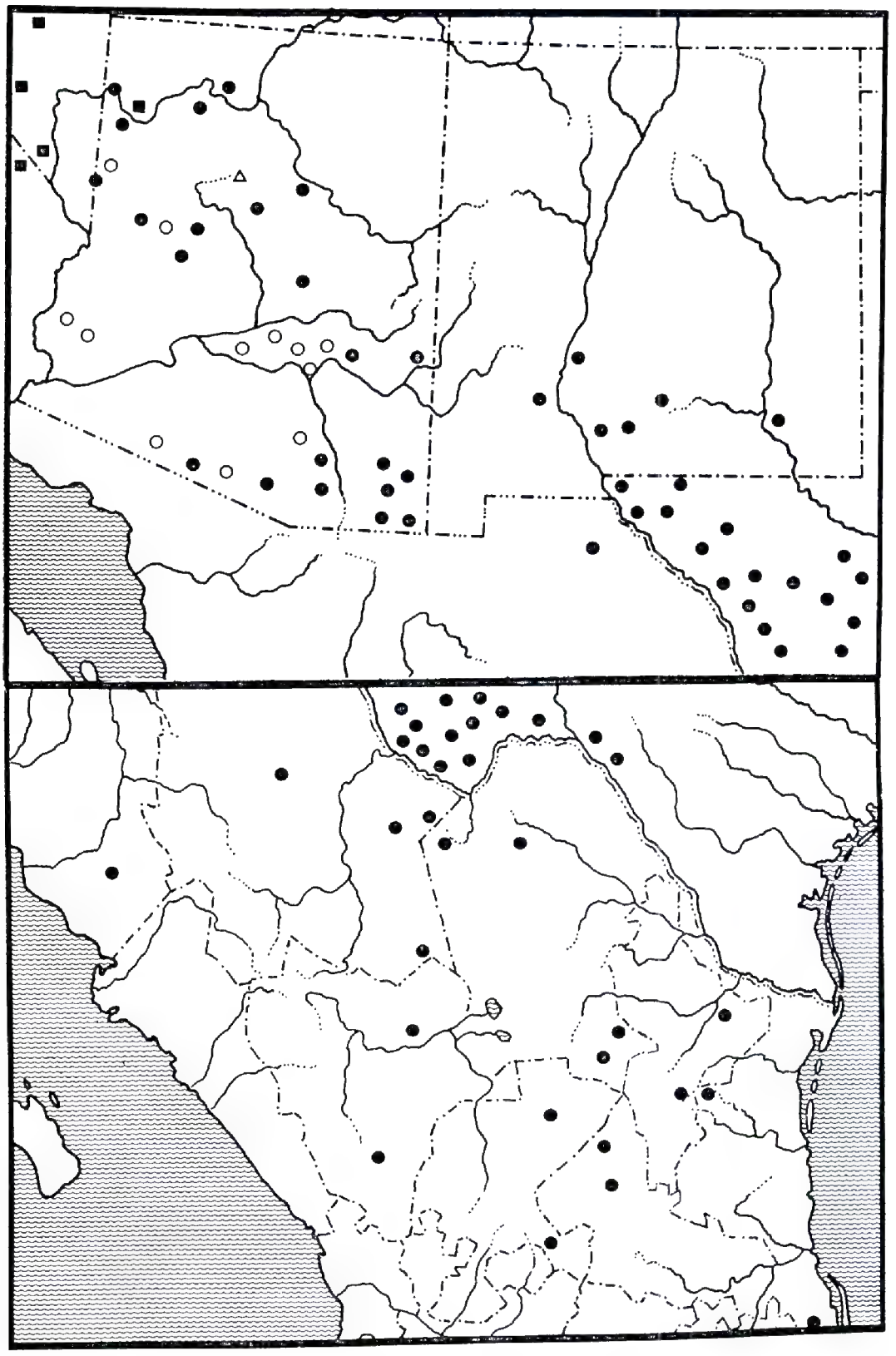


Fig. 6. Distribution of *Hedeoma diffusum* (triangle), *H. nanum* var. *nanum* (closed circles), *H. n.* var. *macrocalyx* (open circles), and *H. n.* var. *californicum* (squares).

Hedeoma thymoides Gray, Syn. Fl. N. Am. 2: 368. 1878. Based on *H. dentatum* var. *nanum* Torr.

Hedeoma nanum Greene, Pittonia 3: 339. 1898. Based on *H. dentatum* var. *nanum* Torr.

Hedeoma nanum (Torr.) Briq. var. *typicum* Stewart, Rep. Spec. Nov. Beihefte 115: 28. 1939. Based on *H. dentatum* var. *nanum* Torr.

Hedeoma nanum (Torr.) Briq. var. *mexicanum* Stewart, Rep. Spec. nov., Beihefte 115: 29. 1939. TYPE: NUEVO LEON. Calcareous hills near Monterrey, 7 Apr 1908, *Pringle 10203* (Holotype, US! isotypes, CAS! F! GH! K! LA! MICH! MSC! NY! PH! SI! SMU! UC! phototype, LA!)

Plants annual or perennial herbs, 5.0–35.0 cm (14.1 cm) high. Shoots solitary to numerous, erect, ascending, or shortly decumbent up to 5.0 cm; branching primary at or near the base, typically unbranched above; shortly pilose or hirsute above, puberulent below, the hairs spreading or retrorsely curling. Leaves ascending to cernuous, ovate to oval, variable in dimension, 2.5–6.0 mm (2.9 mm) wide, 5.5–13.0 mm (7.4 mm) long, margins entire occasionally obscurely crenate, apex broadly acute to narrowly obtuse, base broadly rounded to narrowly attenuated, petiolate, the petiole 0.5–2.5 mm long; the leaf surface glabrous to sparsely pubescent above, margin and undersurface hirtellous pubescent; nerves inconspicuous. Cymules 3–15-flowered (usually between 8 and 10), well-spaced along shoots, or commonly very congested forming a dense but interruped spike of cymes; peduncles inconspicuous to 3.0 mm long; pedicels long, typically exceeding the length of the calyx tube, 3.0–6.0 mm long, clothed in hirsute-hirtellous spreading hairs; bracteoles subulate, shorter than the pedicels they subtend. Calyx 4.0–5.2 mm (4.9 mm) long; the tube 2.5–3.7 mm (3.3 mm) long, saccate or occasionaly gibbous below for 1/2 to 2/3 of the tube's length, the distended region typically more than 1/2 the tube's length, 1.0–1.5 mm wide; the calyx tube densely hirsute to hirtellous with the hairs spreading; the upper calyx teeth connate for slightly less than 1/2 their length forming a conspicuous upper lip, 1.0–1.3 mm long, the lobes narrowly triangular-lanceolate, occasionally approaching subulate, ca 0.3 mm wide at the base, 0.4–0.7 mm long, laterally spreading, and reflexed (commonly at nearly right angles to the axis), hirtellous-ciliate, the inner face of the lip pubescent; the lower teeth subulate, recurved and not conspicuously exceeding the upper lip in length, 1.2–2.0 mm long, hirsute or hirtellous-ciliate; annulus dense, included, ca 0.7 mm wide, seated ca 0.8 mm below the juncture of the upper and lower calyx teeth, and continued upwardly into the inner face of the lower lip. Corolla 8.0–9.0 mm (8.9 mm) long, pubescent within the throat in two decurrent lines, the tube 6.0–7.0 mm long, strongly inflated, ca 3.0 mm wide above; the upper lip subgaleate, the margins and apex revolute, ca 2.0 mm wide, ca 2.0 mm long; the lower lip ca 4.0 mm wide, ca 3.5 mm long. Nutlets oblong, ca 0.5 mm wide, ca 1.1 mm long, areolate and weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 6). Common on rocky, usually calcareous bluffs, ridges,

roadcuts and streamways. Southern Nevada and adjacent California, southeast to southeastern Arizona, east to Trans-Pecos Texas and south to San Luis Potosi, Mexico. Apr–Jul.

TYPE: TEXAS. El Paso Co., Rocky hills of the Rio Grande, near El Paso, 4 May 1852, *Bigelow, s.n.* (Holotype, NY!; isotypes, DS! K! US!).

Hedeoma n. var. *nanum* is a variable taxon which harbours a number of more or less distinct races. One such race received formal recognition as var. *mexicanum* by Stewart and Epling. It is an annual with bristly, spreading stem pubescence and a somewhat shortened calyx and corolla. Representative collections include, *Whiting 950* (LA); and *Lundell 5030* (LA, MICH). Another well-marked race occurs in northern Arizona. It is characterized by long, trailing stems (up to 40 cm long), and exceptionally long internodes, peduncles and pedicels (the peduncles up to 3.0 mm long, and the pedicels up to 6.0 mm long). The following are representative: *Howell 26454* and *26409; Bailey s.n., Clover 5134, Wooton 308,* and *Whiting 1089.*

21b. HEDEOMA NANUM (Torr.) Briq. var. CALIFORNICUM Stewart, Rep. Spec. Nov., Beihefte 115: 29. 1939.

Dense, caespitose perennials forming tufts, 11.0–25.0 cm (17.1 cm) high. Shoots extremely numerous, ascending or shortly decumbent up to 4.0 cm long; branching almost exclusively at or near the base, densely pubescent-puberulent above with hairs retrorsely curling, puberulent below. Leaves small, spreading to cernuous, ovate, 2.0–4.5 mm (3.4 mm) wide, 3.4–8.5 mm (5.0 mm) long, margins entire or obscurely crenate, apex acute, base broadly to narrowly rounded, shortly petiolate, the petiole 0.5–1.5 mm long; leaf surfaces puberulent above, margins and undersurface hirtellous-pubescent; nerves inconspicuous. Cymules 3–5-flowered well-spaced along the upper 2/3–3/4 of the shoots; peduncles 1.0–2.7 mm long; pedicels 3.0–4.3 mm long; bracteoles subulate, shorter than the pedicels which they subtend. Calyx 4.5–5.6 mm (5.1 mm) long; the tube 3.0–4.0 mm (3.3 mm) long, weakly saccate below for ca 2/3 of the tube's length, the distended region 1.2–1.5 mm wide, hirsute-hirtellous to puberulent with the hairs spreading; the upper calyx teeth connate for slightly less than 1/2 of their length forming a conspicuous upper lip, 0.6–1.5 mm long, the lobes triangular, ca 0.4 mm wide at the base, 0.4–0.8 mm long, laterally spreading and slightly to sharply reflexed, hirtellous-ciliate, the inner face glabrate or pubescent; the lower teeth subulate, recurved, not conspicuously exceeding the lower in length, 1.5–2.0 mm (1.8 mm) long, hirsute-ciliate; annulus dense, included ca 0.7 mm wide and seated ca 0.7 mm below the juncture of the upper and lower teeth. Corolla as in *H. nanum* var. *nanum* ca 8.8 mm long. Nutlets 0.6 mm wide, 1.2 mm long, strongly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 6). Frequent on rocky limestone outcrops in the

mountains of the Mojave Desert of California and contiguous areas of southern Nevada and northwestern Arizona. Apr–June.

TYPE: NEVADA. Clark Co., Good Springs, 1 May 1905, *Jones s.n.* (Holotype, LA!; isotypes, CAS! DS! F! GH! POM! US!).

Hedeoma n. var. *californicum* is a relatively uniform taxon separated from the varieties *nanum* and *macrocalyx* by its multi-stemmed, tufted habit, finely puberulent stems and microphyllous leaves.

21c. HEDEOMA NANUM (Torr.) Briq. var. MACROCALYX Stewart, Rep. Spec. Nov., Beihefte 115: 29. 1939.

Somewhat coarse, robust perennial herbs, 15.0–55.0 cm (27.0 cm) high. Shoots numerous, branches ascending at close angles, cansescent above, puberulent below, hairs retrosely curling. Leaves spreading or cernuous, ovate, oval, or elliptical, 5.0–16.0 mm (7.3 mm) wide, 8.0–25.0 mm (12.4 mm) long, margins obscurely crenate, apex broadly acute or obtuse, base broadly rounded to attenuated, petiole 1.5–5.0 mm in length; finely puberulent above, margins and undersurface hirtellous-puberulent; nerves inconspicuous. Cymules 5–7-flowered, well-spaced along the upper 2/3 of the shoots; peduncles 0.5–1.5 mm long; pedicels 3.0–5.0 mm long and typically exceeding the length of the calyx tube; bracteoles subulate usually shorter than the pedicels they subtend. Calyx 6.1–8.0 (6.8 mm) long; the tube 4.0–5.0 mm (4.4 mm) long, slightly gibbous or saccate below for ca 1/2 of the tube's length, the distended region 1.3–1.8 mm wide, sparsely to densely hirsute-hirtellous with hairs spreading; the upper calyx teeth connate for slightly less than 1/2 of their length to form a long and conspicuous upper lip 1.5–2.7 mm (2.0 mm) long, lobes narrowly lanceolate, ca 0.3 mm wide, ca 0.8–1.2 mm long, hirsute-hirtellous-ciliate; the lower teeth subulate, recurved and not conspicuously exceeding the upper lip in length, 2.0–3.0 mm (2.5 mm) long, hirsute-ciliate; annulus dense, included, ca 0.7 mm wide and seated ca 0.8 mm below the junction of the upper and lower calyx teeth. Corolla as in *H. n.* var. *nanum*, 8.0–9.0 mm long. Nutlets ca 0.6 mm wide and 1.4 mm long, strongly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 6). Rocky limestone outcrops and hills of arid central and southwestern Arizona. May–Aug.

TYPE: ARIZONA. Pinal Co., Higley, Queens Creek, 19 May 1926, *Peebles* and *Harrison 1916* (Holotype, LA!).

22. HEDEOMA MICROPHYLLUM Irving, Brittonia 22: 338-340. 1970.

Tufted perennials, 10.0–17.0 cm high. Shoots numerous, decumbent or ascending with branching more or less restricted to the base, puberulent or hirtellous with hairs retrorsely curving. Leaves numerous and crowded, ovate, 3.0–5.0 mm (4.0 mm) wide, 4.0–6.5 mm (5.0 mm) long, margins obscurely serrate, apex acute, base rounded or weakly cuneate, petiolate with a petiole ca 1.0 mm long; surfaces glabrous above, minutely puberulent

below and on the margins; nerves conspicuously elevated. Cymules 1–3-flowered (occasionally up to 5-flowered), crowded along the upper 1/2 of the stems; peduncles inconspicuous, less than 1.0 mm long; pedicels ca 3.0 mm long, clothed in hirtellous spreading hairs; bracteoles shorter than the pedicels they subtend. Calyx 5.5–6.5 mm (6.0 mm) long; the tube 4.0–4.5 mm (4.1 mm) long, saccate below but not markedly so for ca 1/2 of the tube's length, the distended region ca 1.2 mm wide, moderately hirsute with spreading or slightly recurving hairs; the upper teeth connate for ca 1/3 of their length forming an upper lip, ca 1.5 mm long, the lobes reflexed and spreading, narrowly triangular, ca 0.4 mm wide at the base, ca 1.0 mm long, hirsute or hirtellous-ciliate; the lower teeth recurved, subulate, ca 0.5 mm wide at the base, 2.0 mm long, hirsute or hirtellous, ciliate; annulus moderately dense, included, ca 0.5 mm wide and seated at the juncture of the upper and lower teeth. Corolla blue, ca 8.5 mm long, glabrate within; the tube ca 7.0 mm long, slender, only slightly dilated upwardly. ca 0.5 mm wide; the upper lip ligulate, slightly concave, reflexed and emarginate, ca 1.0 mm wide, ca 1.5 mm long; the lower lip ca 2.5 mm wide, ca 3.0 mm long. Nutlets ca 0.5 mm wide, ca 1.0 mm long. Chromosome number, $2n = 36$.

Distribution (Fig. 7). Canyons near San Luis Potosi, Mexico, Jul–Sep.

TYPE: SAN LUIS POTOSI. 10 km east of Guadalcazar, Aug 1966, *Irving 693* (Holotype, TEX!).

23. HEDEOMA MEDIUM Epl., Rep. Spec. Nov., Beihefte 115: 30. 1939.

Caespitose perennials, 10.0–25.0 cm high. Shoots numerous, densely puberulent with retrorsely curling hairs on the upper herbaceous regions of the stems, glabrate below the woody portions; branching confined to the lower half of the plant with the branches ascending at close angles. Leaves deciduous from the lower stem regions with maturity, linear-elliptical, 1.5–5.0 mm (2.4 mm) wide, 6.5–17.0 mm (8.0 mm) long, margins entire, apex acutish, base tapered and subsessile, upper surface glabrate to puberulent, lower surface and margins puberulent; nervation indistinct with only the midrib visible. Axillary buds developed on the immature stems yielding 2–3 leaf pairs. Cymules 1–5-flowered, well-spaced along the upper 2/3 of the shoots, peduncles inconspicuous, less than 0.5 mm long, pedicels 4.0–5.0 mm long, retrorsely puberulent; bracteoles lanceolate, typically shorter than the pedicels they subtend. Calyx 4.2–5.0 mm (4.5 mm) long; the tube 2.5–3.0 mm (2.8 mm) long, conspicuously saccate for ca 2/3 of its length, the distended pouch ca 1.5 mm wide, constricted above; calyx tube glabrate-puberulent; the upper teeth connate for over 2/3 of their length to form a broad, upper lip, 1.0–1.2 mm long, pubescent on its inner face, the lobes deltoid, spreading and reflected, ca 0.3 mm wide at the base, ca 1.3 mm long, the margins glabrate or hirtellous-ciliate; the lower teeth subulate, recurved, 1.4–2.0 mm long, hirtellous or hirsute-ciliate; annulus dense, in-

cluded, ca 0.5 mm wide, seated approximately at the juncture of the upper and lower teeth, extended upwardly onto the inner face of the upper lip. Corolla ca 5.0 mm long glabrous within; the tube ca 4.5 mm long scarcely dilated upwardly, ca 1.2 mm wide; the upper lip ligulate, emarginate, straight, ca 1.3 mm wide, ca 1.5 mm long; the lower lip ca 3.0 mm wide, ca 2.0 mm long. Nutlets ca 0.5 mm wide, 1.0 mm long, the surface foveate, and glaucous. Chromosome number, unknown.

Distribution (Fig. 12). Prairies and pasture lands of Uruguay and Argentina. Nov–Feb.

TYPE: URUGUAY. Sorino, 1 Dec 1935, *Gallinal s.n.* (Holotypes, LA!).

Epling and Stewart comment that *H. medium* is "a species of uncertain quantity and disposition." I, too, am in a quandry over its natural relationships and have placed it only tentatively with *H. nanum* and its allies. The leaf morphology and foveate nutlet surface are very similar to those features of *H. multiflorum* and in habitat and general habit it resembles *H. hispidum.*

24. HEDEOMA COSTATUM Gray.

A number of species have been created from the variable *Hedeoma costatum* complex. Most of the species stem from an attempt, by many workers, to formalize the marked differences observed in morphology between mesophytic and xerophytic representatives of this complex. *H. costatum, H. tenellum, H. quinquenervatum, H. pringeli,* and *H. permixtum* are all names accorded by various authors to the mesophytes. *H. pulchellum, H. albescentifolium* and *H. convisae* are names which were applied to the xerophytes. The taxonomically significant variation between these two basic groups resides primarily in length of bracteoles, degree of leaf dentation, and overall pubescence pattern. However, after careful analysis of herbarium material, I have been unable to recognize these basic morphological groups at the specific level. Instead, I have maintained the complex as a single species separated into two varieties: var. *costatum*, representing the mesophytic populations; var. *pulchellum*, the xerophytic populations.

Representatives of the southern most populations of *H. costatum* (Chiapas, Mexico) were tetraploid in chromosome number ($2n = 72$). These plants, however, displayed no discernable morphological differences accompanying the increase in the ploidy level.

Key to the varieties of *Hedeoma costatum.*

1. Plants variously pubescent but not canescent with hirsute-villous hairs; leaves with margins dentate, often obscurely so; bracteoles narrowly triangular usually shorter than the pedicels; corolla long exserted; plants of central and southern Mexico. ..... 24a. *H.c.* var. *costatum*

1. Plants canescent throughout with stiff hirsute-villous hairs; leaves with margins coarsely dentate; bracteoles subulate, usually conspicuously longer than the pedicels; corolla short barely exserted from the calyx or long exserted; plants of northern Mexico and southwestern United States. ..... 24b. *H.c.* var. *pulchellum*

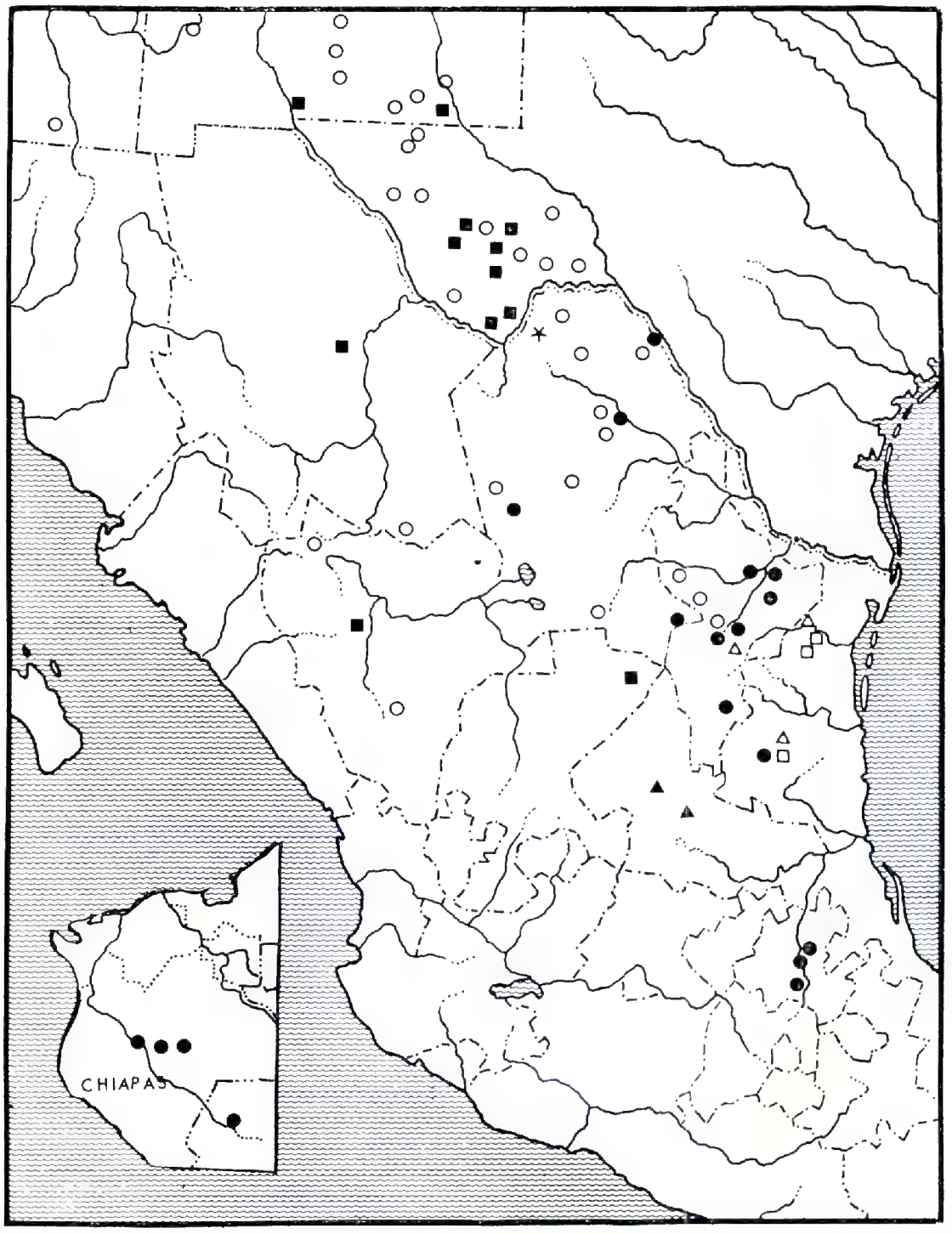


Fig. 7. Distribution of *Hedeoma costatum* var. *costatum* (closed circles), *H. costatum* var. *pulchellum* (open circles), *H. microphyllum* (closed triangles), *H. pilicatum* (closed squares), *H. tenuipes* (open squares), *H. quercetorum* (open triangles), and *H. johnstonii* (asterisk).

24a. HEDEOMA COSTATUM Gray var. COSTATUM, Syn. Fl. 2: 363. 1878.

Hedeoma costatum Hemsl., Biol. Centr. Am. Bot. 2: 547. 1881.
TYPE: CHIAPAS. 1864-1870. *Ghiesbrecht* 815. (Holotype, K!; isotypes, BM! GH! NY!; phototypes, GH! LA! US!).

Hedeoma tenellum Hemsl., Biol. Centr. Am. Bot. 2: 549. 1881.
TYPE: NUEVO LEON. Guajuco, Feb–Oct 1890, *Palmer 1060* (Holotype, K!; isotypes, GH! PH! US!; phototype, LA!).

Hedeoma pringlei Briq., Ann. Conser. et Jardin Bot. Geneve 2: 182. 1898.
TYPE: NUEVO LEON. Wooded slopes of Sierra Madre near Monterrey, 13 Jul 1888, *Pringle 1911* (Holotype G!; isotypes, BM! GH! K! LA! MSC! ND! NY! PH! POM! UC! US!; phototype, LA!).

Hedeoma permixtum Briq., Ann. Conserv. et Jardin Bot. Geneve 2: 183. 1898.
Based on *H. pringlei*.

Hedeoma quinquenervatum Bartlett, Proc. Am. Acad. 44: 634. 1908. TYPE: NUEVO LEON. Sierra Madre above Monterrey, 3000 ft, 9 Apr 1906, *Pringle 10241* (Holotype GH!; isotypes, CAS! F! IA! LA! MICH! MSC! NMC! SMU! TEX! UC! US!).

Extremely variable, loose or tufted perennials, 4.0–36.0 cm (15.0 cm) high. Shoots few to numerous, ascending or shortly decumbent, branching copiously in the lower 1/4 of the plant, the upper branches sparse and short; moderately to densely hirsute in the upper stem regions, the hairs spreading or antrorsely curving, puberulent below. Leaves spreading, membranous, ovate, oval, or elliptical, 3.0–13.0 mm (6.0 mm) wide, 5.0–28.0 mm (10.0 mm) long, margins strongly to obscurely serrate-dentate, apex acute, base broadly rounded or attenuated, the petiole 1.0–4.0 mm long; glabrate or pubescent below with the margin ciliate; nerves not conspicuously elevated. Cymules 3–7-flowered (typically 3–5), well-spaced along the upper 1/2 of the stems or becoming more or less congested toward the apex; peduncles 1.0–3.0 mm long; pedicels 4.0–5.0 mm long, hirtellous with the hairs spreading or retrorsely curving; bracteoles triangular, shorter than the pedicels they subtend. Calyx 5.0–10.0 mm (6.4 mm) long; the tube 4.0–7.0 mm (5.0 mm) long, slightly gibbous for 1/3–1/2 of its length, the distended region, ca 1.1 mm wide, moderately or densely hirsute or hirtellous with the hairs spreading and/or antrorsely curling; the upper calyx teeth connate for 1/4–1/3 of their length forming an upper lip, the lobes narrowly triangular to subulate, 0.2–0.5 mm wide at the base, 1.5–2.5 mm long, laterally spreading and reflexed, hirsute or hirtellous-ciliate; the lower teeth recurved, subulate, ca 0.5 mm wide at the base, 2.0–3.0 mm long, hirsute or hirtellous-ciliate; annulus moderately dense, included, ca 0.5 mm wide and seated at the juncture of the upper and lower calyx teeth. Corolla, well-exserted from the calyx, 9.0–20.0 mm (12.0 mm) long, pubescent in the throat and the tube but not forming a well-defined annulus; the tube 8.5–18.5 mm (11.5 mm) long, slightly dilated upwardly, ca 2.0 mm wide; the upper lip flat, ligulate, slightly reflexed upwardly and emarginate, ca 1.5 mm wide, 1.5 mm long; the lower lip 3.0–4.0 mm wide, 2.0–3.0 mm long. Nutlets 0.6 mm wide, ca 1.2 mm long, the surface

minutely areolate, weakly glaucous. Chromosome numbers, $2n = 36, 72$.

Distribution (Fig. 7). Pine Oak Forest of the Sierra Madre Oriental, Nuevo Leon to Hidalgo and Chiapas. 8000–10,000 ft. Jun–Sept.

TYPE: CHIAPAS. 1864-1870, *Ghiesbreght 815* (Holotype, GH!; isotypes, BM! K! LA! NY!; phototypes, GH! LA! US!).

24b. HEDEOMA COSTATUM Gray var. PULCHELLUM (Greene) Irving, Brittonia 22: 345. 1970.

Hedeoma pulchellum Greene, Leaflets Bot. Obs. 1: 213. 1906. Basionym.

Hedeoma albescentifolium Bartlett, Proc. Am. Acad. 44: 633. 1908. TYPE: CHIHUAHUA. Santa Eulalia Mountains, Apr 1885, *Pringle 133* (Holotype, GH!; isotypes, F! NY! POM! PH! UC! US!).

Hedeoma convisae A. Nels., Am. Bot. 23: 270. 1936. TYPE: NEW MEXICO. Eddy Co., Carlsbad Caverns, chaparral, Apr 1930, *Convise 6* (Holotype, RM!; isotype, LA!).

Densely tufted perennials up to 15.0 cm high. Shoots numerous, ascending, or shortly decumbent; branching in the lower half; canescent with retrorsely curling hirsute hairs. Leaves spreading, membranous, ovate or elliptical, 3.0–6.5 mm (4.8 mm) wide, 5.0–10.0 mm (7.8 mm) long, margins coarsely serrate, apex sharply acute, base rounded or shortly cuneate with a petiole ca 1.0 mm long; puberulent to nearly villous above, strigose to villous below and on the margins; nerves not conspicuously raised. Cymules 3–5-flowered, typically congested in the upper 1/2 of the stems; peduncles 1.0–2.0 mm long; pedicels ca 4.0 mm long, hoary-villous with the hairs spreading or pubescent with the hairs retrorsely curling; bracteoles subulate usually conspicuously longer than the pedicels they subtend. Calyx 6.5–8.0 mm (7.2 mm) long; the tube 4.5–5.5 mm (5.0 mm) long, saccate-gibbous for ca 1/2 of its length, the distended region ca 1.3 mm wide, typically hoary-villous, occasionally pubescent, hairs spreading or antrorsely curving; the upper teeth connate for ca 1/4 of their length forming an upper lip 2.0–3.0 mm long, the lobes slightly reflexed and laterally spreading, subulate, ca 0.3 mm wide at the base, 2.0 mm long, hirsute-ciliate; the lower teeth recurved, subulate, ca 0.4 mm wide at the base, 2.0–3.0 mm long, hirsute-ciliate; annulus dense, included, ca 0.5 mm wide and seated at the juncture of the upper and lower teeth. Corolla dimorphic: in the first form white, slender and about equal to the length of the calyx, the lobes minute; in the second form blue, long and well-exserted from the calyx tube, 10.0–20.0 mm (14.0 mm) long, pubescent in the throat and tube but not annulate; the tube 8.5–18.5 mm (10.5 mm) long, slightly dilated upwardly ca 1.5 mm wide; the upper lip ligulate, slightly reflexed and emarginate ca 1.5 mm wide, ca 1.5 mm long; the lower lip 3.0–4.0 mm wide, 2.0–3.0 mm long. Nutlets ca 0.6 mm wide and 1.2 mm long, the surface minutely areolate, weakly glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 7). Arid calcareous mountain regions of northern Mexico, western Texas and southern New Mexico. 3000–7000 ft. May–Jul.

TYPE: NEW MEXICO. Sierra Co., Kingston, 6600 ft, 19 May 1905, *Metcalf 1599* (Holotype, ND!; isotype, NMC!; phototype, LA!).

25. HEDEOMA JOHNSTONII Irving, SIDA 7(2): 103-106. 1977.

Wiry perennial herbs up to 30.0 cm tall; shoots ascending or decumbent, numerous, branching primarily from the base and rooting at the lower nodes, glabrous except for a minute tuft or retrorsely curling hairs at each node. Leaves spreading or ascending, stiff membranous in texture, glabrous, conspicuously glandular punctate on the lower surface, ovate-oblanceolate, 10.0–20.0 mm long, 4.0–7.0 mm wide, dentate with 4–5 pairs of teeth terminating the costae, apex acute, base attenuate to a short petiole ca 1.5 mm long, midrib and secondaries conspicuously elevated. Cymules 1–3-flowered, well-spaced along the upper one-third of the stem; primary peduncles ca. 1.0 mm long; primary pedicels ca. 3.0 mm long; bracteoles lanceolate, equal to or slightly longer than the pedicels. Calyx 10.0–15.0 mm long (base to tip of upper teeth), tubular-funnelform, not gibbous, sparsely hirsute; upper teeth partially united forming a small but conspicuously reflected lip, the lobes triangular ca 1.0 mm long, sparsely ciliate; lower teeth deltoid below ca 1.0 mm wide, abruptly tapering to an aristate apex, ca 1.0–2.0 mm long, hirsute-ciliate; annulus located just below the teeth, included. Corolla showy, long and slender, up to 45 mm long from its base to the tip of the upper lip, pink-violet, broadly annulate within where seated in the calyx; upper lip short, ca 4.0 mm long, 3.0 mm wide, emarginate; the lower lip spreading, ca 5.0 mm long, ca 3.0 mm wide, Nutlets 2.0 mm long, 1.0 mm wide. Chromosome number unknown.

Distribution (Fig. 7). Canyons and igneous slopes of the Sierra Del Jardin, Coahuila, Mexico. 1500–2250 m. Jul–Sep.

TYPE: COAHUILA: Canyon Hundido on north side of Pico de Centinela, Sierra del Jardin, 8 km e. of Rancho El Jardin. "Steep canyon through igneous sierra, gravelly and sandy loam derived from extrusive igneous rocks, 1500–2250 m." 27 July 1973: *M. C. Johnston, F. Chiang, T. L. Wendt* and *D. Riskind 11803.*

Hedeoma johnstonii is a distinctive species apparently endemic to the steep igneous slopes of the Sierra del Jardin, Coahuila, Mexico. Its habit is very reminiscent of *Hedeoma bellum*, an endemic of the mountains of the western coast of Mexico, but, in the details of its calyx and corolla is more closely allied to *Hedeoma costatum* and its allies. It is readily separated from all species of *Hedeoma* by its exceptionally long and showy corolla.

26. HEDEOMA PLICATUM Torr., Bot. U.S. Mex. Bound. Surv., part 2, 130. 1859.

Perennial herbs, 15.0–37.0 cm high. Shoots typically numerous, ascending or very shortly decumbent, copiously branched towards the base, sparsely so above with the branches short; hirtellous above with the hairs retrorsely

curving, puberulent below. Leaves spreading or ascending, membranous, elliptical or rhombic, 3.0–6.0 mm (4.4 mm) wide, 5.4–10.0 mm (7.9 mm) long, margins coarsely serrate, with the serrations typically confined to the upper 1/2 of the blade, apex acute, base broadly attenuated to a short petiole, ca 1.0 mm long; glabrous or puberulent above, puberulent or hirtellous below on the nerves and margins; nerves conspicuously elevated. Cymules 3–7-flowered (typically 3–5), well-spaced along the upper 2/3 of the stems; peduncles short ca 1.0 mm long; pedicels 3.0–4.0 mm long, hirtellous pubescent with retrorsely curling hairs; bracteoles short. Calyx 4.5–6.0 mm (5.9 mm) long the tube 3.4–4.2 mm (4.0 mm) long, pronouncedly gibbous for ca 1/2 of the tube's length, the distended region ca 1.3 mm wide, the tube puberulent with short spreading hairs or with hairs antrorsely curling; the upper calyx teeth connate for 1/2 of their length forming an upper lip ca 3.0 mm long, the lobes narrowly triangular-lanceolate, ca 0.3 mm wide at the base, ca 1.4 mm long, laterally spreading and sharply reflexed, hirsute or hirtellous-ciliate; the lower calyx teeth subulate, recurved, ca 0.4 mm wide at the base, ca 2.0 mm long, hirsute-ciliate; the annulus moderately dense, included, ca 0.5 mm wide and seated at least 1.0 mm below the juncture of the upper and lower teeth. Corolla blue, 7.0–10.0 mm (9.0 mm) long, very sparsely pubescent in the throat in two decurrent lines, sparsely short pubescent in the tube; the tube 5.5–8.5 mm (7.5 mm) long, dilated upwardly, ca 2.5 mm wide above; the upper lip straight, concave and subgaleate, slightly emarginate, ca 2.0 mm wide, ca 1.5 mm long, the lower lip 2.5–3.0 mm wide, 2.5–3.0 mm long. Nutlets ca 0.5 mm wide, 1.0 mm long, the surface minutely areolate, weakly glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 7). Pine-oak woodlands of the mountainous areas of southern New Mexico, western "trans-Pecos" Texas, and the northern Mexico, 5000–8000 ft. Jul–Sep.

TYPE: TEXAS. Jeff Davis Co., near Fort Davis in the Limpia creek area, dry ravines near the Limpia Mts., July 1849 *Bigelow s.n.* (Holotype, NY!; isotypes, K! US!).

Hedeoma plicatum is a variable species which intergrades into *H. costatum* var. *pulchellum*. *Hedeoma c.* var. *pulchellum* is a xerophytic, spring flowering plant, whereas *H. plicatum* is a mesophytic, late summer or fall flowering plant. Morphologically, two characters have emerged to distinguish the two species. The leaves of *H. plicatum* are more or less rhombic with raised straight costae on the undersurface; the leaves of *H.c.* var. *pulchellum*, on the other hand, are ovate with the nerves unraised and usually curved and branched. The annulus of *H. plicatum* is seated at least 1.0 mm below the juncture of the upper and lower calyx while that of *H.c.* var. *pulchellum* is positioned directly at the juncture.

27. HEDEOMA TENUIFLORUM Brandegee, Zoë 5: 254. 1908.

Robust perennials, 30.0-35.0 cm high with numerous shoots long and

ascending, bristly-hirsute pubescent with spreading hairs above, puberulent below, branching basally from a woody caudex. Internodes elongated, up to 5 cm long. Leaves spreading or ascending, membranous, elliptical-ovate to somewhat rhomboid, 3.0–4.0 mm (3.9 mm) wide, 9.0–13.5 mm (11.0 mm) long, margins entire, or obscurely crenate, apex acute, base narrowly attenuate petiolate, the petioles 2.0–4.0 mm long; margins and both surfaces puberulent with short, stiff, spreading hairs; nervation indistinct, secondaries barely visible. Cymules 1–3-flowered, well-spaced along the upper 1/2 of the stems; peduncles ca 1.5 mm long; pedicels 3.5–4.0 mm long, densely hirsute with spreading hairs; bracteoles subulate shorter than the pedicels they subtend. Calyx ca 9.0 mm long; the tube ca 6.0 mm long, distinctly gibbous below, the distended region ca 1.0 mm wide, the tube dilated above, pubescent with short spreading hairs; the upper teeth connate for slightly less than 1/2 of their length forming a somewhat broadened, rounded upper lip ca 2.0 mm long, the margins more or less outwardly extended, the lobes reflexed, narrowly triangular-subulate, ca 0.3 mm wide at the base, ca 1.0 mm long, hirtellous-ciliate; the lower teeth triangular-subulate, slightly recurved, ca 0.4 mm wide at the base, ca 3.0 mm long, hirsute-ciliate; the annulus ca 0.7 mm wide but seated ca 1.0 mm below the juncture of the upper and lower teeth. Corolla 17.0–18.0 mm long, exserted, pubescent within but not annulate; the tube ca 15.0 mm long not dilated above. Nutlets ca 0.5 mm wide, ca 1.3 mm long, no mature nutlets seen. Chromosome number, unknown.

Distribution. Known only from the type locality.

TYPE: BAJA CALIFORNIA. El Rancho Viejo, 30 Apr 1889, *Brandegee s.n.* (Holotype, UC!; isotypes, PH! US!).

Several features of this rare species suggest an affinity with *H. oblongifolium.* However, until there is more material available for study *H. tenuiflorum* will be retained with *H. costatum* and its allies.

28. HEDEOMA MARTIRENSE Moran, Trans. San Diego Soc. Nat. History 15(17): 275–277. 1969.

Loose, wiry perennial herbs, 8.0–10.0 cm high forming mats or clumps. Shoots numerous, strongly decumbent and forming adventitious roots from the lower nodes; branching copiously throughout, the branches ascending at close angles; densely hispid-hirtellous above with spreading or retrorsely curving hairs up to 0.5 mm long, glabrate below with the lower portions becoming somewhat woody. Shoots of the previous season persistent. Leaf pairs crowded with the internodes 2.0–5.0 mm long, usually confined to the upper 1/4 of the shoots. Leaves membranous, spreading, ovate 2.0–3.0 mm wide (2.7 mm), 5.0–6.0 mm long (5.4 mm), margins entire, apex obtuse, base petiolate, the petiole 1.0–1.5 mm long; leaf surfaces glabrous above and on the margins, strigulose below. Nerves raised. Flowers solitary in the upper leaf axils and restricted to the distil portions of the branches,

peduncles 2.0 mm long, pedicels 2.0–3.0 mm long, hirtellous with spreading hairs; bracteoles linear 1.0–2.0 mm long, shorter than the pedicels they subtend. Calyx 8.0–8.5 mm long, tubular, slightly sigmoid, saccate below for ca 1/3 of its length, ca 1.2 mm wide, flaring distally; the tube 5.5–6.5 mm long, weakly strigulose below the hairs spreading; the upper lip connate for ca 1/3 of its length, the lobes triangular ca 0.5 mm wide at the base, ca 1.5 mm long, slightly reflexed, ciliate; lower teeth 0.7 mm wide at the base, 2.5 mm long, triangular-lanceolate, ciliate; annulus ca 0.5 mm wide, weakly developed, seated at the juncture of the upper and lower lips, included. Corolla white or pinkish, long and slender, 20.0–22.0 mm long, glabrous within; the tube ca 19.0 mm long dilated above, ca 2.5–3.0 mm wide; the upper lip obcordate, slightly galeate, ca 2.0 mm wide, 2.5–3.0 mm long, shallowly notched; lower lip ca 4.0 mm wide, ca 3.0 mm long. Filaments quite short ca 3.0 mm long and arising just below the juncture of the upper and lower corolla lips (unique for *Hedeoma*). Nutlets brown, oblong, 0.5–0.7 mm wide, 1.4–1.6 mm long. Chromosome number, unknown.

Distribution. North facing pine-fir covered slopes and on east facing open escarpments of N. Central Sierra San Pedro Martir, 7–9,000 ft. May–Aug.

TYPE: BAJA CALIFORNIA. East rim of Sierra San Pedro Martir, N. of Perba Buena, 1 June 1968, *Moran 15069* (Holotype, SD 67322!; isotypes, K, MEXU, MONTU! UC, US).

Hedeoma martirense is a rare and somewhat enigmatic taxon. In many of its morphic features, its large showy solitary flowers, its decumbent rhizomatous habit, and its short leaf internodes, it shows strong phenetic affinities to *H. diffusum*. In the remainder of its characters however, especially in its long, slender exserted corolla, and leaf structure it is most closely related to *H. tenuiflorum*, also endemic to Baja California.

29. HEDEOMA QUERCETORUM Epl., Rep. Spec. Nov., Beihefte 115: 41. 1939.

Lax perennial herbs, 15.0–30.0 cm high. Shoots few, ascending or shortly decumbent, branching basally with the branches widely ascending; puberulent-pubescent above with retrorsely curved hairs, glabrate below. Leaves spreading or ascending, membranous; the lower leaves ovate-elliptical, 4.0–5.0 mm (4.5 mm) wide, 10.0–14.0 mm (12.0 mm) long, the upper leaves lanceolate or narrowly elliptic, at least four times as long as wide, 2.0–3.0 mm (2.4 mm) wide, 12.0–30.0 (14.7 mm) long, margins entire or obscurely crenate, apex acute or narrowly obtuse, base narrowly attenuate and subsessile, the surfaces pubescent or glabrate above, sparsely pubescent below and on the margins; nerves more or less elevated. Cymules 1–3-flowered, well-spaced along the upper 1/2 of the shoots, peduncles 0.5–1.0 mm long; pedicels 3.0–6.0 mm long, pubescent or puberulent; bracteoles linear-lanceolate. Calyx 7.0–8.2 (7.7 mm) long; the tube 4.0–5.5 mm (4.9

mm) long, tubular-sigmoid and slightly gibbous below, the distended region 1.3–1.5 mm wide, densely hirsute pubescent with spreading hairs; the upper calyx teeth united less than 1/5 of their length forming an upper lip 1.5–2.0 mm long, the lobes narrowly triangular, 0.3–0.4 mm wide at the base, 1.5–1.8 mm long, spreading, erect or slightly reflexed, hirsute-ciliate; the lower teeth triangular-subulate, recurved, ca 0.5 mm wide at the base, 2.7–3.0 mm long, hirsute-ciliate; the annulus sparse, included, ca 0.6 mm wide seated at the juncture of the upper and lower teeth. Corolla lavender, long exserted, ca 17.0 mm long, pubescent within the tube forming a broad annulus; the tube long and narrow, not at all dilated upwardly, 15.0 mm long, 1.2 wide above; the upper lip obcordate-ligulate, emarginate, ca 1.0 mm wide, ca 1.5 mm long; the lower lip ca 5.0 mm wide, ca 3.5 mm long. Nutlets oblong-ovate, ca 0.6 mm wide, ca 1.2 mm long, the surface areolate and glaucous. Chromosome number, unknown.

Distribution (Fig. 7). Oak woodland associations of the Sierra Madre Oriental of eastern Mexico in the states of Nuevo Leon and Tamaulipas. 7000–9000 ft. Jul–Sep.

TYPE: NUEVO LEON. Sierra Madre Oriental, San Francisco Canyon, ca 16 miles SW of Pueblo Galeana, 7500–8000 ft, 16 May 1934, *C.H. & M.T. Mueller 411* (Holotype, LA!; isotypes, GH! TEX!).

Hedeoma quercetorum is very closely related to *tenuipes*. The morphological differences reside principally in the number of flowers per cymule, the length of the calyx, and the length of the corolla. The variation in these characters as displayed by these two species, however, is no greater than that displayed in the single species *H. costatum*, but, until further field studies are carried out, they will be treated as distinct.

30. HEDEOMAS TENUIPES Epl., Rep. Spec. Nov., Beihefte 115: 39. 1939.

Lax perennials, 25.0–30.0 cm in height. Shoots strict or ascending, branching primarily in the lower half with the branches widely ascending from the main axis; stems pubescent-puberulent with retrorsely curling hairs above, glabrate below. Leaves spreading, membranous; the lower leaves broadly ovate-elliptical 4.5–8.0 mm (6.1 mm) wide, 1.0–1.7 mm (1.3 mm) long; the upper leaves linear-lanceolate, at least five times longer than wide, 1.8–3.0 mm (2.2 mm) wide, 12.0–17.0 mm (15.3 mm) long, margins entire or obscurely crenate, apex acute, base narrowly attenuated and subsessile, surfaces glabrate above, pubescent below with short hairs on the nerves and margins; nerves slightly raised. Cymules 3- over 20-flowered, well-spaced along the upper 1/2 of the stems, occasionally congested, peduncles ca 1.0 mm long; pedicels 4.5–6.7 mm long, sparsely pubescent; bracteoles linear, nearly equal to the pedicels they subtend. Calyx 5.0–6.0 (5.6 mm) long; the tube 3.0–3.7 mm (3.6 mm) long, tubular and not at all gibbous below, or only slightly so, ca 1.0–1.2 mm wide, hirtellous pubescent with the hairs spreading or antrorsely curved; the upper calyx

teeth united less than 1/5 of their length forming an upper lip 1.0–1.5 mm long, the lobes narrowly triangular, ca 0.3 mm wide at the base, 0.9–1.2 mm long, slightly reflexed, hirsute-ciliate; the lower teeth triangular-subulate, erect or slightly recurved, ca 0.4 mm wide at the base, 2.0–2.5 mm long, hirsute-ciliate; the annulus, included, sparse, ca 0.5 mm wide, seated at the juncture of the upper and lower teeth. Corolla small, white, barely exserted from the calyx tube, glabrous within, ca 5.5 mm long; narrowly tubular, ca 1.0 mm wide above; the upper lip ligulate, ca 1.0 mm wide, ca 0.8 mm long, emarginate; the lower lip ca 2.0 mm wide, 1.2 mm long. Nutlets ca 0.6 mm wide, ca 1.3 mm long, the surface areolate, glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 7). Oak woodlands of the Sierra Madre Oriental, Tamaulipas, Mexico. 2000–5000 ft. Jul–Sep.

TYPE: TAMAULIPAS. "Cerro Zamora near El Milagro," 25 Aug 1930, *Bartlett 1117* (Holotype, F!; isotypes, MICH! LA!; phototype LA!).

31. HEDEOMA HYSSOPIFOLIUM Gray, Proc. Am. Acad. 11: 96. 1876.

Plants perennials forming dense, wiry tufts or large clumps, 15.0–47.0 cm (29.1 cm) high. Shoots numerous, ascending, or decumbent, rhizomatous, producing adventitious roots at the nodes of the short subterranean portions of the stems; the upper regions glabrate or pubescent, but usually puberulent with retrorsely curved hairs, puberulent or hirtellous below; branching almost exclusively confined to the basal regions. Leaf pairs more or less crowded, equal to or exceeding the internodes. Leaves glabrate membranous, narrowly lanceolate to linear, at least five times longer than wide, and commonly more, 1.0–2.0 mm (1.8 mm) wide, 8.0–18.5 mm (13.4 mm) long, margins entire, the apex narrowly acute, the base tapered and sessile; nerves prominent but not strongly elevated. Axillary buds form a cluster of 2–3 axillary leaf pairs. Cymules 1–7-flowered (typically 3–flowered), well-spaced or somewhat congested along the upper 1/2 of the shoots; peduncles 0.5–3.0 mm long; pedicels 3.0–5.0 mm long, puberulent to pubescent; bracteoles variable, subulate-lanceolate, typically exceeding the length of the pedicels they subtend. Calyx long and slender, 6.0–8.3 mm (7.5 mm) long, the calyx tube 4.9–5.5 mm (4.2 mm) long only slightly or not at all gibbous below, tubular-funnelform, dilated above, 1.0–1.5 mm wide, typically glabrous or puberulent with short stiff spreading hairs in the proximal region, glabrous distally; the upper calyx teeth connate for ca 1/5 of their length forming an upper lip 1.0–1.6 mm long, the lobes narrowly triangular to subulate, ca 0.2–0.5 mm wide at the base, 0.9–1.6 mm long, erect and parallel or slightly laterally spreading, glabrous or tuberculate on the margins; the lower teeth long subulate, recurved, ca 0.2 mm wide at the base, 1.7–3.0 mm long, hirsute or hirtellous-ciliate; annulus dense, 0.7–1.0 mm wide, exserted, seated approximately at the juncture of the upper and lower teeth and extended upwardly onto the in-

nerfaces of the teeth. Corolla lavender; 11.0–16.0 mm (14.1 mm) long, pubescent within the tube but not annulate; the tube dilating upwardly, but not abruptly so, 2.0–3.0 mm wide above; the upper lip broadly ligulate in outline, emarginate, with margins outwardly flaring, 1.5–4.0 mm wide, 2.2–5.0 mm long; the lower lip up to 7.0 mm wide, 5.0 mm long. Nutlets ca 0.6 mm wide, ca 1.3 mm long, the surface areolate, weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 8). A common member of the herbaceous understory flora of mature, open pine stands in the mountains of southeastern Arizona, southwestern New Mexico and northern Mexico, lower montane to subalpine associations, 6000 to 10,000 ft. Most commonly a member of the upper montane association and found frequently in recently burned areas. Aug–Sep.

TYPE: ARIZONA. Graham Co.: Mt. Graham, 9000 ft., Aug 1874, *Rothrock 418* (Holotype, GH!; Fragment, LA!; isotypes, F! K! NY! PH! US!; phototype LA!).

Hedeoma hyssopifolium is probably the most easily recognized taxon in the genus *Hedeoma*. This distinctiveness is due to its narrow, linear leaves, cylindrical, puberulent calyx, and large showy flowers. Although readily recognized, it nevertheless houses considerable variation. The most notable variation is revealed in the disjunct populations of northern Mexico (Fig. 8). These populations are easily recognized and perhaps deserve varietal status. Their glabrous stems, subulate-filiform calyx teeth, and sparce annulus, all combine to set these plants apart from their more northwestern counterparts.

Hedeoma hyssopifolium intergrades into *H. oblongifolium* and *H. dentatum*; most often through hybridization at the lower altitudes where these species come is contact.

32. HEDEOMA OBLONGIFOLIUM (Gray) Heller

Key to the varieties:

1. Corolla glabrous within, leaves broadly elliptical; plants of U.S. ..... 32a. *H. oblongifolium* var. *oblongifolium*
1. Corolla annulate within, leaves narrowly elliptical, plants of Mexico. ..... 32b. *H. oblongifolium* var. *mexicanumm*

32a. HEDEOMA OBLONGIFOLIUM (Gray) Heller var. OBLONGIFOLIUM, Muhlenbergia 1: 4. 1900.

Hedeoma piperitum Benth. var. *oblongifolium* A. Gray, Proc. Am. Acad. 8: 366. 1872. Basionym.

Hedeoma thymoides A. Gray var. *oblongifolium* A. Gray, Syn. Fl. N. Am. 2: 362. 1878.

Stout, herbaceous perennials, 20.0–55.0 cm high, forming robust tufts. Shoots few to many, usually under 10, densely pubescent above with retrorsely curling hairs to hoary-pilose above with long, spreading hairs, puberulent

below, stems ascending strictly from a slender rootstock; branching confined to the basal regions with secondary branches few and arising well after the maturity of the primaries. Leaves spreading, membranous, narrowly elliptic-ovate or linear-elliptic, at least twice as long as wide, 5.5 mm (4.3 mm) wide, 8.5–14.0 mm (11.9 mm) long, margins denticulate, apex narrowly and sharply acute, base tapered and shortly petiolate with the petiole 0.9–1.5 mm long; the surfaces glabrate or pubescent above, undersurface and margins somewhat unevenly hirtellous; nerves more or less raised. Basal foliage distinct, broadly ovate, entire, glabrous above, minutely hirtellous below. Axillary buds arise early in the shoot development and form a cluster of 2–3 leaf pairs. Cymules 5–15-flowered, dense and congested along the upper 2/3 of the shoots; peduncles inconspicuous to 0.5 mm long; pedicels 4.0–7.0 mm long and commonly exceeding the length of the calyx tube, sparsely to densely hirtellous; bracteoles subulate-lanceolate ca equal to the length of the pedicels they subtend. Calyx 5.5–7.0 mm (6.2 mm) long; the tube 4.0–5.0 (4.5 mm) long, gibbous below for ca 1/3 of the tube's length, the distended region 1.0–1.2 mm wide, hirtellous of short spreading hairs to densely hirsute-pilose; the upper calyx teeth connate for ca 1/5 of their length forming an upper lip 1.0–1.3 mm long, the lobes narrowly triangular, 0.1–0.3 mm wide at the base, 0.7–1.0 mm long, laterally spreading and reflexed, ciliate; the lower teeth subulate, recurved, ca 0.2 mm wide at the base, 1.3–2.0 mm long, hirsute-ciliate; the annulus dense somewhat exserted, ca 0.5 mm wide, seated approximately at the juncture of the upper and lower teeth. Corolla lavender, 10.0–11.0 mm (10.5 mm) long, glabrous within; the tube 8.0–9.0 mm (8.5 mm) long and only slightly dilated upwardly, ca 1.5 mm wide above; the upper lip, flat, ligulate, ca 1.2 mm wide, ca 2.0 mm long, emarginate, conspicuously shorter than the lower lip, and reflexed away from the axis; the lower lip ca 4.0 mm wide, ca 4.0 mm long. Nutlets ca 0.5 mm wide, ca 1.0 mm long, the surface areolate and weakly glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 8). Common on the slopes of the oak-woodland, chaparral associations in mountainous regions of central and southern Arizona, New Mexico and adjacent areas of northern Sonora, Mexico. 5000–8000 ft. Aug–Sep.

TYPE: NEW MEXICO. 1851-52, *Wright 1515* (Holotype, NY!; isotypes, BM! F! GH! K! PH! UC! US!).

Hedeoma oblongifolium is more or less intermediate between the mesic montane species *H. hyssopifolium* and the xerophytic *H. dentatum*.

32b. HEDEOMA OBLONGIFOLIUM (Gray) Heller var. MEXICANUM Irving, Brittonia 22: 342–344. 1970.

Stout perennials 28.0–40.0 cm high, forming tufts. Shoots ascending, usually under 10, pubescence of tightly retrorsely curling hairs above,

puberulent below, branching mostly confined to the lower regions of the stem with the secondary branches long and ascending at close angles. Leaves spreading, thick membranous, narrowly elliptical or linear, at least three times as long as wide, 1.5–4.0 mm (2.8 mm) wide, 9.0–13.0 mm (10.8

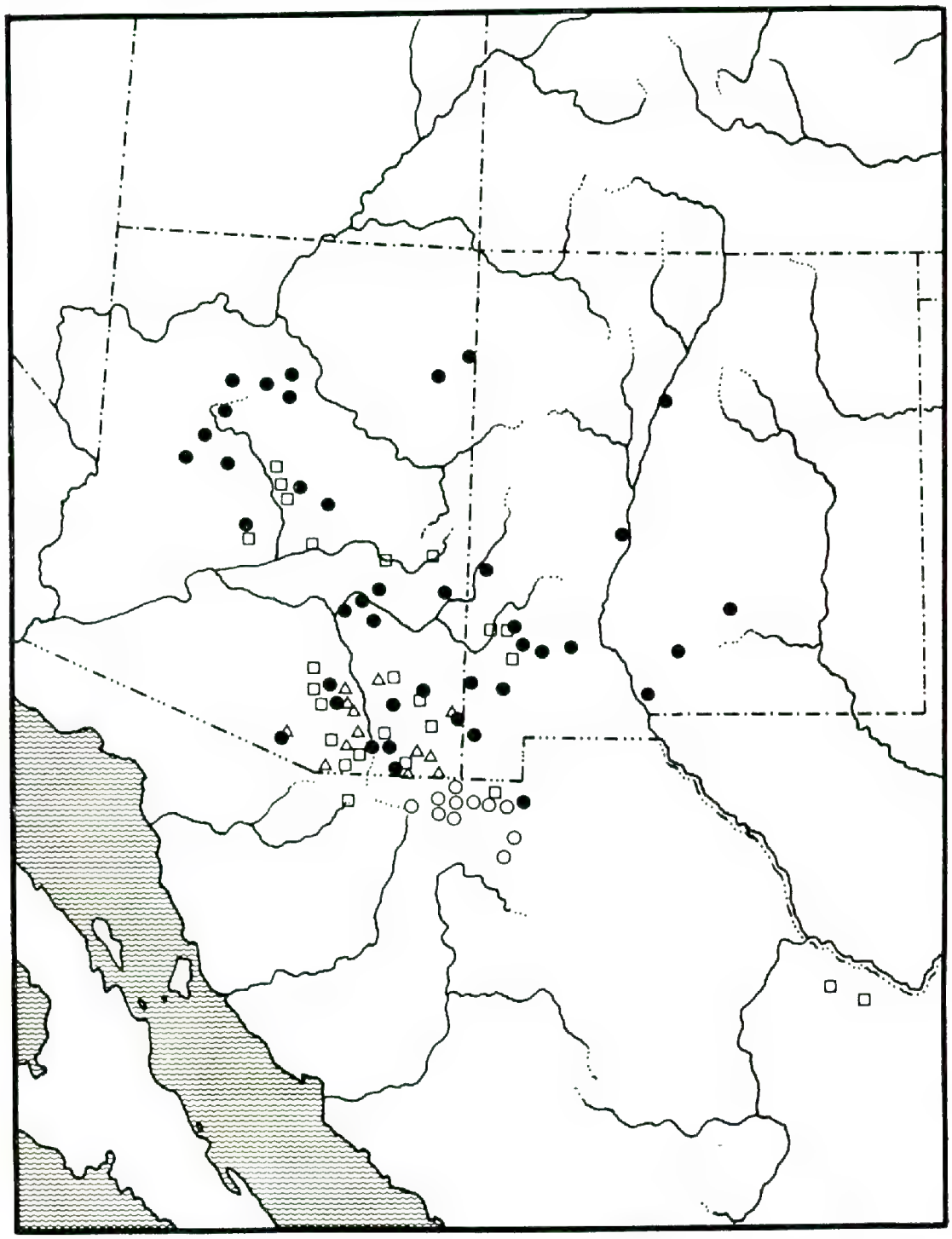


Fig. 8. Distribution of *Hedeoma hyssopifolium* (open squares), *H. oblongifolium* var. *oblongifolium* (closed circles), *H. oblongifolium* var. *mexicanum* (open circles), and *H. dentatum* (open triangles).

mm) long, the margins denticulate with the teeth confined to the upper regions of the blade, the apex sharply acute, the base tapered and subsessile; surfaces glabrous to glabrate above, glabrate below; nerves elevated. Basal foliage distinct, narrowly elliptic to ovate, entire, and evenly glabrate. Axillary buds arise early in the shoot development and form a cluster of 2–3 leaf pairs. Cymules 5–10-flowered, dense and congested, well-spaced or crowded along the upper 2/3 of the shoots; peduncles inconspicuous; pedicels, 4.0–5.0 mm long, puberulent; bracteoles lanceolate, ca equal to the length of the pedicels they subtend. Calyx 5.2–5.8 mm (5.5 mm) long; the tube 3.7–4.2 mm (4.0 mm) long, gibbous below for ca 1/2 of the tube's length, the distended region 1.0–1.2 mm wide, slightly tapered above, hirtellous with short, stiff, spreading hairs; the upper calyx teeth only slightly united for ca 1/5 or their length forming an upper lip 0.9–1.0 mm long, the lobes narrowly triangular, subulate, 0.1–0.2 mm wide at the base, 0.8–0.9 mm long, laterally spreading and reflexed; the lower teeth subulate, ca 0.3 mm wide at the base, 1.2–1.7 mm long, hirsute-ciliate; annulus dense partially exserted, ca 0.5 mm wide and seated approximately at the juncture of the upper and lower teeth. Corolla lavender, 8.0–9.0 mm long, annulate within of short pilose hairs seated at the juncture of the tube and throat; the tube 6.8–7.8 mm (7.0 mm) long, slightly dilated upwardly, ca 2.0 mm wide above; the upper lip ligulate, emarginate, ca 10 mm wide, 1.2 mm long, conspicuously shorter than the lower lip, and reflexed away from the axis; the lower lip ca 3.0 mm wide, ca 3.0 mm long. Nutlets ca 0.5 mm wide ca 1.0 mm long, the surface areolate and glaucous. Chromosome number, unknown.

Distribution (Fig. 8). Common in the oak-woodland and chaparral associations in the mountains of northern Sonora and Chihuahua, Mexico. 6000–9000 ft. Aug–Oct.

TYPE: SONORA. Puerto del Cumarito, Sierra de la Cabellera, 5400 ft. 6 Oct 1941, *White 4638* (Holtoype, MICH!; isotypes, GH! US.).

33. HEDEOMA DENTATUM Torr., Bot. U.S. Mex. Bound, Surv., part 2, 130. 1859.

Tall herbaceous perennials, 29.0–40.0 cm tall, forming robust clumps. Shoots long, few to many, densely hirtellous pubescent with spreading or curling hairs; branching confined to the lower 1/2, the branches long, ascending and arising well after the maturity of the primary shoots. Leaves spreading, ovate, elliptic, or rhombic, at least twice as long as wide, 3.0–5.0 mm (4.1 mm) wide, 8.0–17.0 mm (10.3 mm) long, margins coarsely serrate-dentate, apex sharply acute, base tapered and subsessile, upper surface sparsely strigulose to glabrate, under-surface and margin hirtellous with short, stiff, spreading hairs; nerves raised. Basal foliage broadly ovate or obovate, coarsely serrate with both surfaces densely and evenly hirsute-pilose. Axillary buds develop early in the shoot development and form a cluster of

2–3 leaf pairs. Cymules 5–15-flowered (typically between 5–7), dense and congested along the upper 1/2 of the shoots; peduncles 0.2–1.1 mm long; pedicels 3.2–4.5 mm long and commonly exceeding the length of the calyx tube, pubescent; bracteoles lanceolate equal in length to the pedicels they subtend. Calyx 4.8–5.5 mm (5.2 mm) long; the tube 3.4–4.0 mm (3.8 mm) long, gibbous or slightly saccate for 1/3–1/2 of the tube's length, 0.9–1.2 mm wide below, slightly tapered above, hirtellous with short, stiff, spreading hairs; the upper teeth slightly connate for ca 1/5 of their length forming an upper lip 1.0–1.6 mm long, the lobes subulate, ca 0.2 mm wide at the base, 0.7–0.9 mm long, laterally spreading and reflexed, hirtellous-ciliate; the lower teeth subulate, recurved ca 1.5–1.7 long, hirsute-ciliate; annulus dense somewhat exserted, ca 0.5 wide, seated approximately at the juncture of the upper and lower teeth. Corolla lavender, 8.0–9.0 mm (8.5 mm) long, annulate within with short pilose hairs; the tube 6.5–7.5 mm (7.4 mm) long, only slightly dilated upwardly, ca 1.5 mm wide above; the upper lip flat, ligulate, ca 1.2 mm wide, 1.5 mm long, emarginate, conspicuously shorter than the lower lip, and reflexed away from the axis; the lower lip ca 3.5 mm wide, ca 3.5 mm long. Nutlets ca 0.5 mm wide, 1.0 mm long, the surface areolate and glaucous. Chromosome number, $2n = 36$.

Distribution (Fig. 8). Common on open, well-drained soils in the oak woodland and chaparral associations in the mountains of central and southeastern Arizona, and adjacent Mexico. 5000–10,000 ft. Aug–Oct.

TYPE: SONORA. Santa Cruz, Sep 1851, *Thurber s.n.* (Holotype, NY!; isotypes, F! GH! US!).

Hedeoma dentatum intergrades with both *H. hyssopifolium* and *H. oblongifolium*. Hybridization probably accounts for the latter as there is at least one documented case of gene exchange between *H. dentatum* and *H. hyssopifolium* in the Huachuca mountains.

Epling and Stewart (1939) have postulated that *H. dentatum* is the result of past hybridization between *H. oblongifolium* and *H. plicatum*. However, it seems more likely that *H. dentatum* was selected out of peripheral populations of *H. oblongifolium* in response to xeric conditions.

34. HEDEOMA ACINOIDES Scheele, Linnaea 22: 592. 1849.

Delicate, ephemeral annuals, 5.0–30.0 cm (15.2 cm) high, arising from a very slender taproot. Shoots solitary to numerous, erect, ascending or very shortly decumbent for 1.0–2.0 cm; branching absent or restricted to the lower 1/2 of the shoots with the branches ascending from the main axis at wide angles; densely pubescent above, nearly lanate with the hairs strongly retrorsely curving or curling, puberulent below. Leaves spreading or cernuous, membranous, narrowly or broadly ovate, elliptical, or rhombic-elliptical, 3.5–8.0 mm (5.8 mm) wide, 9.0–25.0 mm (14.2 mm) long, margins entire or obscurely serrate with the serrations restricted to the distil 1/2 of

the blade, apex obtuse, base rounded to narrowly attenuate, petiolate with the petiole 1.0–4.0 mm (2.6 mm) long; the surfaces glabrate or minutely strigulose on nerves and margins; nerves except for the midrib unelevated. Cymules 3–15-flowered and typically congested toward the apices forming a short dense spike of cymules; peduncles inconspicuous, less than 1.0 mm long; pedicels 2.0–5.0 mm long, shortly pubescent; bracteoles lanceolate-subulate, ciliate, the primary pair equal in length to the pedicels they subtend. Calyx 5.0–6.1 mm (5.3 mm) long, thin membranous; the tube relatively long and slender, 4.0–4.5 mm (4.1 mm) long, the lower 1/3 distinctly saccate below, the distended region ca 1.2 mm wide, the tube glabrate or sparsely hirtellous on the lower 1/2 and with the hairs confined to the primary nerves; upper calyx teeth united for ca 1/3 of their length forming small but definite upper lip, 0.9–1.2 mm long, the lobes broadly to narrowly triangular, ca 0.2 mm wide at the base, 0.8–1.1 mm long, parallel or only slightly reflexed, densely hirtellous-ciliate; the lower teeth narrowly triangular to subuate, recurved, ca 0.4 mm wide at the base, 1.0–1.2 mm long, hirtellous-ciliate; the upper and lower teeth partially closing the orifice through convergence; annulus very weakly represented, consisting of only a few short hairs, ca 0.4 mm wide, seated ca 0.3 mm below the junction of the upper and lower teeth. Corolla pink, 9.0–13.0 mm (11.0 mm) long, the throat very slightly dilated upwardly ca 0.6 mm wide above; the upper lip ligulate and reflexed at right angles to the corolla tube, very slightly emarginate, 1.0–1.5 mm wide; 2.0–4.0 mm long; the lower lip 4.0–5.0 mm wide, 3.0–4.0 mm long. Nutlets small, 0.4 mm wide, ca 0.8 mm long, the surface areolate, not glaucous or only very slightly so. Chromosome number, $2n = 34$.

Distribution (Fig. 9). Common, in wet years, in the rocky limestone soil along the eastern periphery of the Edwards Plateau and Lampasas Cut Plain. It also occurs in limestone pockets of the South Coastal Plains of Texas and in the calcareous hills surrounding Monterrey, Mexico. Apr–May.

TYPE: TEXAS. Comal Co., in the vicinity of New Braunfels, April, *Roemer s.n.* (Holotype, not located).

Within this species a form can be recognized that is small, more heavily pigmented, glabrate and with entire leaves. Based on field observations in Travis Co., Texas, this form is apparently adapted to more xerophytic locations and often forms subpopulations several inches to several yards in size.

In its interspecific relationships, *H. acinoides* is somewhat of an enigma. Its morphological attributes, in combination, are quite unique. Although Epling and Stewart (1939) have suggested an affinity with *H. quercetorum*, I can find no morphological or chemical substantiation for such an idea. In its overall habit and vegetative morphology, *H. acinoides* shows some similarity with the eastern annual, *H. pulegioides*. The calyx, corolla, and

seed morphology, however, readily separate *H. acinoides* from this latter species.

H. acinoides has the same chromosome number ($2n = 34$) as the partially sympatric taxa, *H. reverchonii, H.r.* var. *serpyllifolium, H. drummondii*

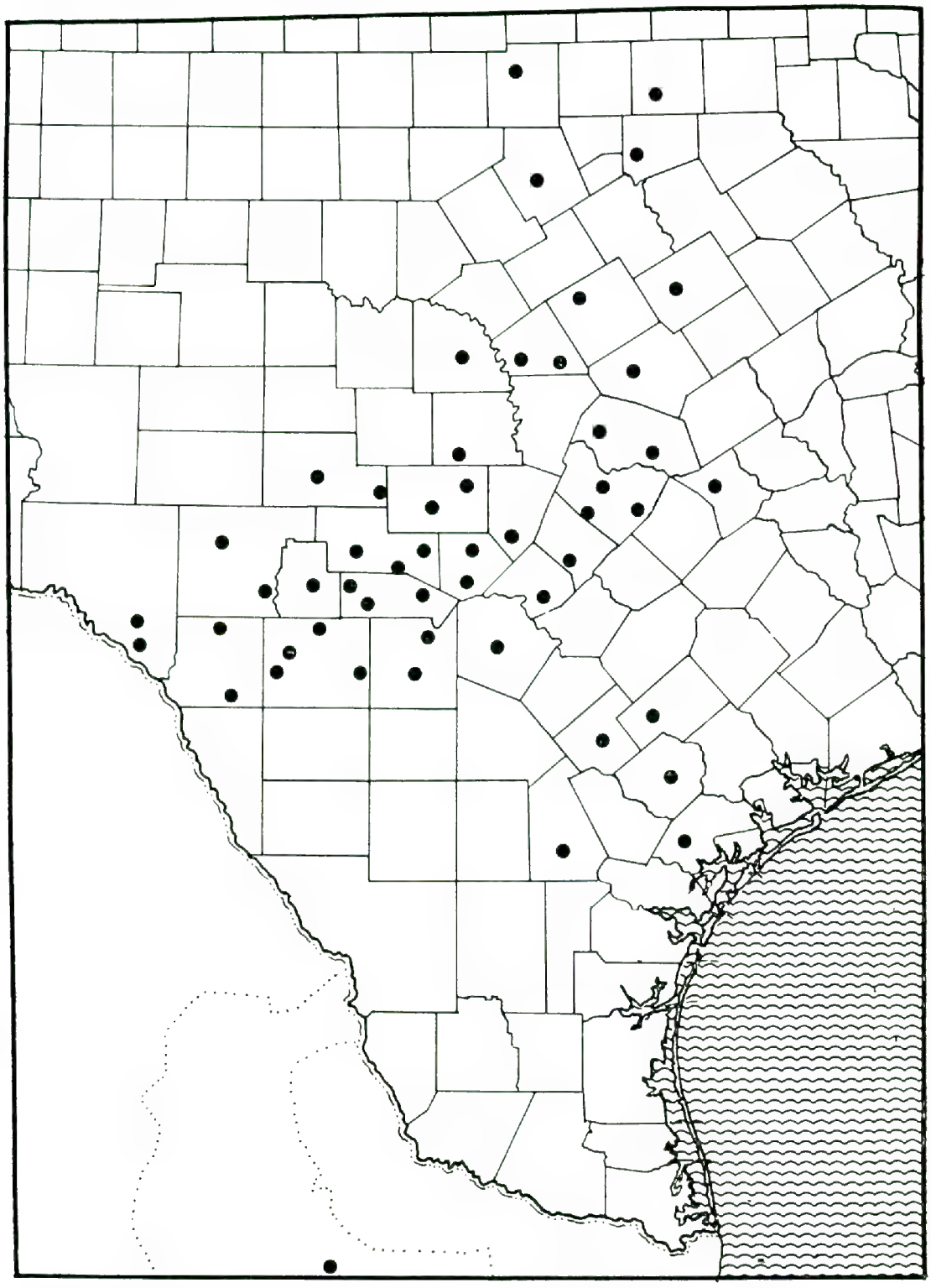


Fig. 9. Distribution of *Hedeoma acinoides* (closed circles).

(in part), and *H. hispidum*. As the latter 4 taxa are apparently closely related, it is quite possible that *H. acinoides* is a highly derived species stemming from the *H. drummondii* complex. Morphological support of this is seen in the convergence of the upper and lower calyx teeth, a feature also characteristic of *H. drummondii* and its allies.

35. HEDEOMA HISPIDUM Pursh, Fl. Am. Sept. 2: 414. 1814.

Hedeoma hirtum Nutt., Gen. 1: 16. 1818. Nom. superfl. TYPE: ARKANSAS [Terr.?]. On open alluvions of the Missouri, June. *Nuttall s.n.* (Lectotype. here designated GH!; isotype, K!).

Ziziphora hispidum (Pursh) R. & S., Syst. Mant., 1: 179. 1822. Based on *H. hispidum*.

Hedeoma hispidum Pursh forma *simplex* Lalonde, Nat. Canad. 85: 71. 1958. TYPE: QUEBEC. Pontiac Co., Vinton, 27 Aug 1956, *P. Louis-Marie 561a* (Holotype, CAN; isotype, GH!).

Coarse annuals, 9.0–40.0 cm (21.6 mm) in height, arising from a very slender taproot. Shoots slender, sharply quadrangular, usually solitary, occasionally numerous, erect or shortly decumbent for 2.0–3.0 cm; branches absent or consisting of 2–6 pairs, long ascending and usually confined to the lower 1/3 of the plant; shoots densely pubescent above with relatively long, retrorsely curling hairs, becoming puberulent below. Leaves typically spreading, coriaceous with the margins frequently becoming revolute, linear or linear-elliptic, usually over 5 times longer than broad, 1.0–3.0 mm (2.2 mm) wide, 11.0–21.0 mm (16.4 mm) long, margins entire, apex obtuse, base narrowly attenuated and subsessile, surfaces glabrate above, strigulose below and on the margins; nerves not conspicuously elevated. Cymules born along the upper 2/3 of the stems, occasionally along its entire length, well-spaced or commonly congested forming a pronounced "spike", 3–15-flowered but typically 5–8-flowered; peduncles inconspicuous less than 1.0 mm in length; pedicels 2.0–5.0 mm long, hirsute; bracteoles stiff and acute, narrowly lanceolate to subulate, hirsute-ciliate, longer than the pedicels they subtend. Calyx highly zygomorphic, 4.9–6.0 mm (5.2 mm) long; the tube 2.8–3.2 mm (2.9 mm) long, markedly saccate below for ca 3/4 of its length, 1.5–2.0 mm wide below, pubescent with hairs long hirsute and spreading; the upper calyx teeth connate for ca 1/2 of their length forming a broad, expanded upper lip, 1.2–2.0 mm long with margins outwardly flaring and exceeding the width of the tube below, the connate portion silky pubescent within on its inner face, the lobes narrowly triangular, laterally spreading, hirtellous-ciliate, ca 0.5 mm wide at the base, 0.5–0.9 mm long; the lower teeth recurved and subulate, 2.0–2.5 mm long, hirsute-hirtellous-ciliate; annulus dense, slightly exserted, ca 0.5 mm wide and seated at the juncture of the upper and lower teeth. Corolla dimorphic; the first form blue or white, small, disproportionately so in reference to the calyx, ca 5.3 mm long and scarcely exserted from the calyx tube, glabrous within. The second form blue, considerably larger, ca 6.0–7.0 mm long, and well exserted from

the calyx, glabrous within, the upper lip subgaleate, the lower spreading. Nutlets ca 0.6 mm wide, ca 1.2 mm long, the surface areolate and strongly glaucous. Chromosome number, $2n = 34$.

Distribution (Fig. 10). Rich, loamy soil of prairie and pasture lands from Vermont west to Alberta, Canada, south to south-central Texas and eastern Florida, along the Gulf coastal plain. Apr–June.

TYPE: On the banks of the Missouri, *Nuttall s.n.* (Holotype, PH!).

Hedeoma hispidum is one of the most widespread of the taxa of *Hedeoma*, rivaled only by *H. drummondii* and *H. pulegioides* in total area of distribution.

Because of its breeding behavior, its annual habit, and chromosome number, *H. hispidum* is believed to be derived. Its morphology can be traced to two possible precursors—*H. nanum* and *H. drummondii*, themselves closely related to one another.

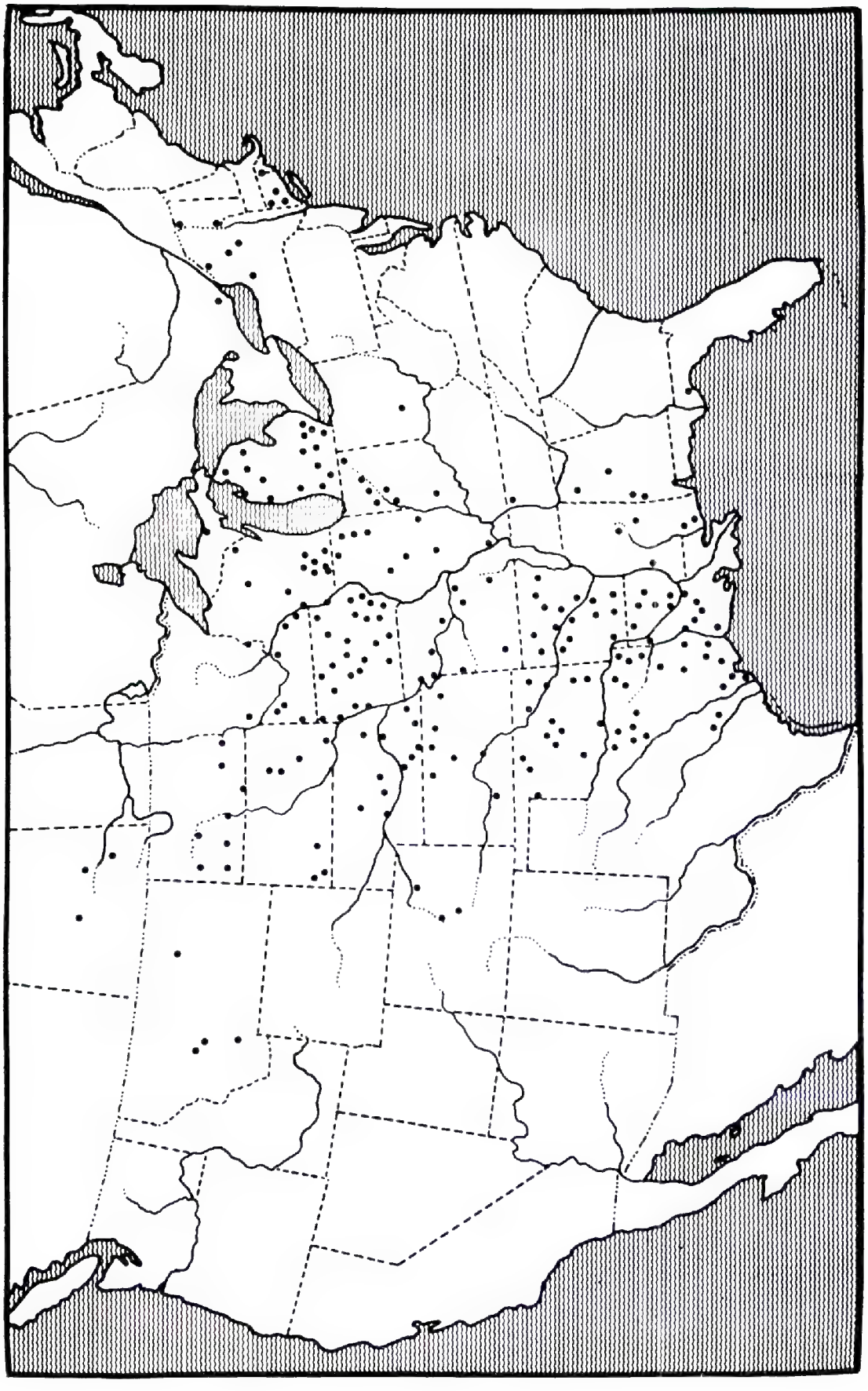
In past studies *H. hispidum* has always been associated with *H. pulegioides* to which it displays a close similarity in its overall morphology. However, differences in nutlet structure, fine details of the calyx, corolla, and chromosome number clearly set *H. hispidum* apart from the latter (see discussion following treatment of *H. pulegioides*).

IV. Subgenus Hedeoma

Loose, wiry perennials of robust annuals, 5.0–40.0 cm high. Shoots solitary to numerous, erect, ascending or shortly decumbent, arising from a slender taproot. Leaves well-spaced, membranous and spreading, ovate, or elliptical, 3.5–11.0 mm wide, 5.0–32.0 mm long, margins dentate or crenate, base petiolate, the leaf surfaces strigose or glabrous, glandular dotted. Flowers in 1–15-flowered axillary cymules. Calyces strongly zygomorphic, 3.5–5.0 mm long, the tube weakly to strongly saccate for over 1/2 of its length; the upper teeth united for 1/2 to 2/3 of their length to form a broad, expanded, upper lip, the lobes semi-ovate, deltoid, or triangular, erect or reflexed; the lower teeth short scarcely exceeding the upper lip in length, ciliate. Corolla short, 3.0–8.5 mm long (in *H. pulegioides* and *H. crenatum* barely exserted from the calyx tube); the upper lip broadly ligulate, deeply emarginate (for ca 1/2 of its length); the lower lip not spreading, more or less held erect, nearly equally 3-lobed. Nutlets orbicular in outline or nearly so, black in color at maturity, the surface ruminate, not becoming mucilaginous when moistened, not glaucous. Chromosome number, $2n = 36$.

The subgenus *Hedeoma* is composed of 3 species which, despite their wide geographical separation, appear to form a natural unit. The salient morphological features which hold the group together are the highly zygomorphic calyx, small corolla, and orbicular, black, nonmucilaginous nutlets.

Fig. 10. Distribution of *Hedeoma hispidum*.



36. HEDEOMA PULEGIOIDES (L.) Pers., Syn. 113. 1807. Based on *Melissa pulegioides.*

Melissa pulegioides L., Sp. Pl. ed 1,593. 1753.
Cunila pulegioides L., Sp. Pl. ed. 2, 30. 1772. Based on *Melissa pulegioides.*
Ziziphora pulegioides (L.) Desf., Table. ed. I: 55. 1804; ed. II: 66. 1815. Based on *Melissa pulegioides.*
Hedeoma pulegioides (L.) Pers. forma *simplex Lalonde*, LaRevue D'Oka 32: 151. 1958. TYPE: QUEBEC. Papineauville, 10 Aug 1937. *Desilets s.n.* (Holotype, CAN).

Robust annuals, 10.0–40.0 cm high, arising from a slender taproot. Shoots typically solitary, erect, straight, branching freely in the middle region with the branches long and ascending, densely puberulent with retrorsely curling hairs above, glabrate below. Leaves spreading or cernuous, deciduous from the lower 1/2 of the plant with maturity, membranous, narrowly to broadly elliptical or nearly oblong, 4.0–11.0 mm (5.9 mm) wide, 12.0–32.0 mm (19.0 mm) long, margins obscurely to sharply dentate, apex narrowly obtuse, base attenuated and petiolate, the petiole 2.5–7.0 mm long; leaf surfaces glabrous or minutely strigulose on the nerves; nervation not prominent. Cymules 3–15-flowered, typically well-spaced along the upper branches, occasionally congested; peduncles 0.5–1.0 mm long; pedicels 3.0–3.5 mm long, puberulent; bracteoles shorter than the pedicels. Calyx highly zygomorphic, 3.5–4.5 mm (4.1 mm) long; the tube 2.0–2.5 mm (2.2 mm) long, markedly saccate below for ca 2/3 of its length, the distended region 1.3–1.6 mm wide, sparsely hirtellous or glabrate below with the hairs spreading; the upper calyx teeth connate for ca 2/3 of their length forming a broad, expanded, upper lip, 2.0–2.5 mm long with the margins rounded, and exceeding the width of the tube below, the connate portion of the lip glabrous on its inner face, the lobes narrowly triangular, ca 0.5 mm wide at the base, 0.5–0.7 mm long, laterally spreading and reflexed, glabrous on the margins; the lower teeth short, barely exceeding the upper lip in length, subulate and recurved, ca 0.5 mm wide at the base, 1.5–2.5 mm long, hirsute-ciliate; the annulus sparse, included, ca 0.5 mm wide and seated at the juncture of the upper and lower lips. Corolla minute, barely exserted from the calyx tube, ca 4.0 mm long, glabrous within; the tube ca 3.0 mm long, dilated upwardly, ca 1.5 mm wide above; the upper lip ligulate, ca 0.8 mm wide at the base, ca 1.0 mm long, straight, deeply emarginate; the lower lip erect, equally 3-lobed, ca 2.0 mm wide, 1.0 mm long; nutlets 0.9 mm wide, 1.0 mm long, black, the surface ruminate, not glaucous. Chromosome number $2n = 36$.

Distribution (Fig. 11). Open woodlands and waste ground throughout central and eastern U. S., eastern Kansas and Oklahoma eastward to South Carolina and northward to Nova Scotia, Canada. Aug–Sep.

TYPE: Plants of the Gronovian Herbarium of which *Clayton 514* has been suggested as the standard (Epling 1939) (Lectotype, here designated BM).

Hedeoma pulegioides is a very widespread and distinct species which has, traditionally, been grouped with *H. hispidum*. Indeed, these two species formed a separate section in the revision by Epling and Stewart (1939). Although there are several morphological features shared by these species, notably the annual habit and the saccate calyx, their differences, as for example the features of the nutlet, outweigh their similarities.

Hedeoma pulegioides is most closely related to *H. crenatum* of Brazil. Only habit and leaf shape distinguish these two taxa from one another.

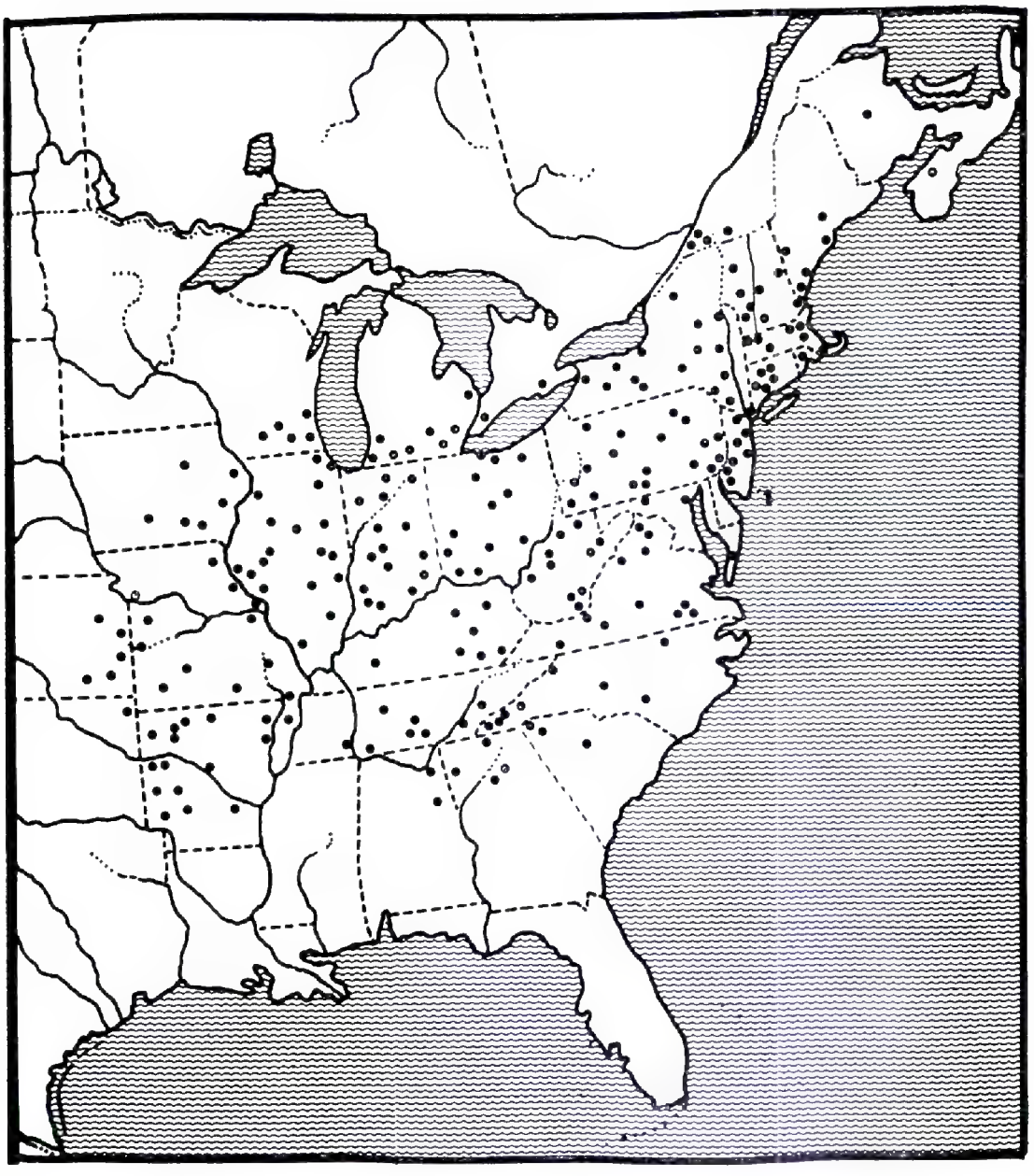


Fig. 11. Distribution of *Hedeoma pulegioides*.

37. HEDEOMA CRENATUM Irving, Britt. 22: 344–345. 1970. Based on *Pseudocunila montana* Brade.

Hedeoma polygalaefolium Benth. var. *montanum* Dusén, Arch. Mus. Nac. XIII. 35. 1903. TYPE: BRAZIL. Serra do Itatiaia, March 1894. *Ule 199* (Holotype, R).

Pseudocunila montana Brade, Rodriguesia 7: 27. 1944.

Cunila montana Brade ex Epl., Britt. 7: 140. 1951. TYPE: BRAZIL. Rio de Janeiro, Serra dos Orgaos, Estado do Rio Castello, 2100 m, 17 Jan 1945. *Segadas Vianna 675* (Holotype, LA!).

Hedeoma montanum (Brade) Epl. & Jativa, Britt. 15: 369. 1963 (not Brandegee 1913). Based on *Cunila montana* Brade.

Loose, wiry perennials, perhaps biennials, 15.0–30.0 cm high. Shoots numerous, typically decumbent and rhizomatous, producing adventitious roots from the lower nodes, densely pubescent with spreading or retrorsely curving hairs, branching mostly at or near the base. Leaves spreading, occurring all along the stems, membranous, ovate-spatulate, 4.0–5.0 mm (4.6 mm) wide, 9.0–10.0 mm (9.5 mm) long, glabrous, margins crenate especially along the upper 1/2 of the blade, apex obtuse, base rounded and petiolate with the petiole 2.5–3.0 mm long; nervation inconspicuous. Cymules 1–3-flowered, well-spaced along the upper 1/2 of the stems; peduncles inconspicuous; pedicels ca 2.5 mm long and puberulent; bracteoles shorter than the pedicels they subtend. Calyx highly zygomorphic, ca 4.0 mm long; the tube ca 2.0 mm long, hirtellous, markedly saccate for over 3/4 of its length, the distended region ca 1.0 mm wide; the upper calyx teeth connate for ca 1/2 of their length forming an expanded, upper lip, ca 2.0 mm long, with the margins rounded, the lobes semi-ovate, ca 0.7 mm wide at the base, ca 1.0 mm long, more or less erect, hirtellous-ciliate; the lower teeth short barely exceeding the upper lip in length, narrowly triangular, ca 0.5 mm wide at the base, ca 2.0 mm long, hirtellous-ciliate, erect or slightly recurved; annulus dense, included, ca 0.5 mm wide, seated just below the juncture of the upper and lower teeth. Corolla minute, barely exserted from the calyx tube, ca 3.0 mm long, pubescent within; the tube ca 2.0 mm long, slightly dilated upwardly, ca 1.0 mm wide at the summit; the upper lip broadly ligulate ca 1.5 mm wide, 1.0 mm long, straight, flat, and deeply emarginate; the lower lip erect, nearly equally 3-lobed, ca 2.0 mm wide, ca 1.0 mm long. Nutlets 0.8 mm wide, 1.0 mm long, the surface ruminate, and not glaucous. Chromosome number, unknown.

Distribution (Fig. 12). Brazil, in the mountains of Minas Geraes and Rio de Janeiro. 6,000–7,000 ft. Nov–Jan.

TYPE: BRAZIL. Rio de Janeiro, Serra dos Orgaos, 2200 m, *A.C. Brade 11,500* (Holotype, RF!).

38. HEDEOMA MANDONIANUM Wedd., Chlor. And. 2: 148. 1860.

Hedeoma breviflorum Griseb. in Lechler, Berb. Am. Aust. 58. 1857, nomen. TYPE: PERU. "Agapata," Jun 1854, *Lechler 1848* (Holotype, K!).

Hedeoma adscendens Rusby, *Phytologia* 1: 74. 1934. TYPE: BOLOVIA. Cordillera

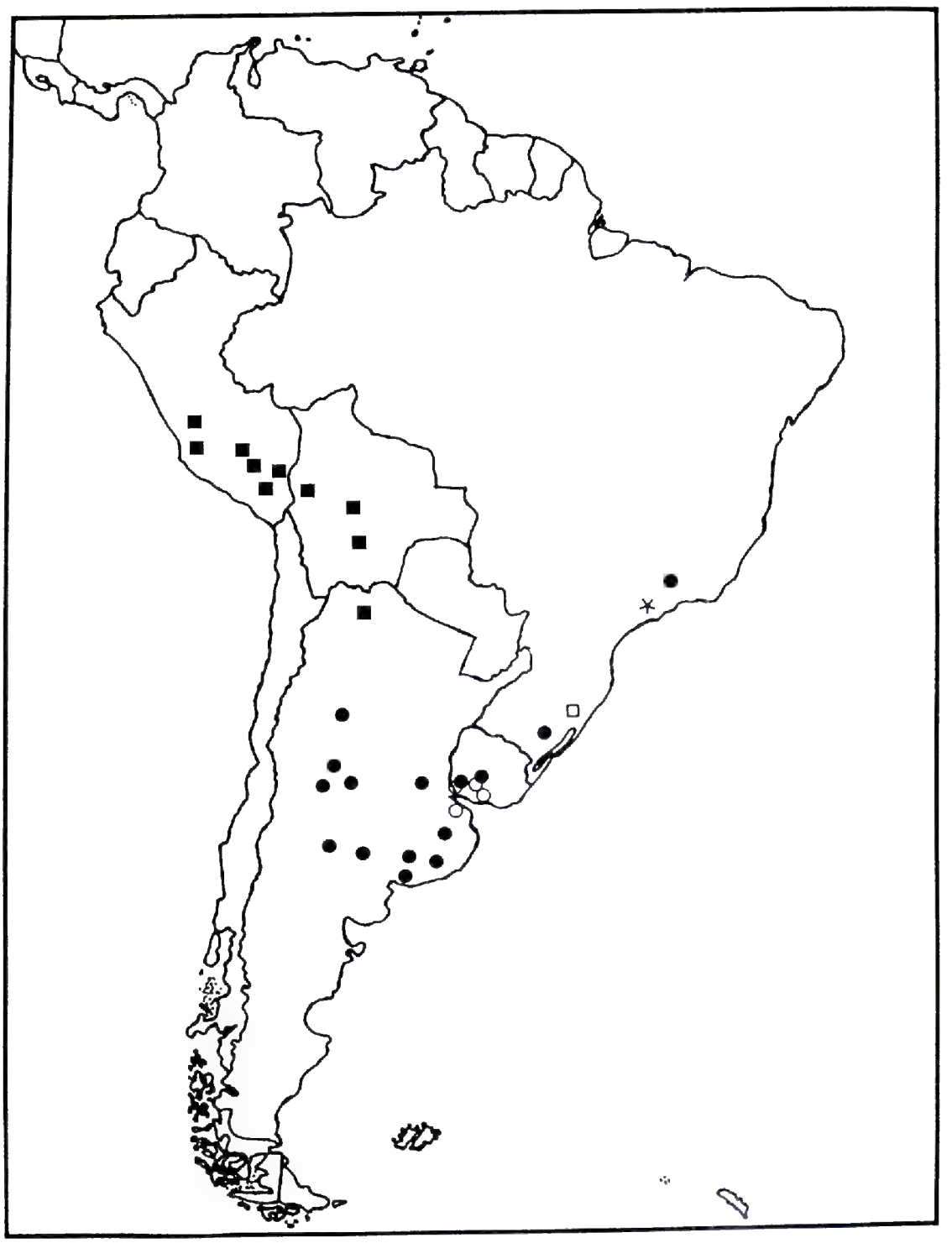


Fig. 12. Distribution of *Hedeoma multiflorum* (closed circles), *H. medium* (open circles), *H. crenatum* (open square), *H. mandonianum* (closed square) and *H. polygalaefolium* (asterisk).

Real, top of the pass on the Tipuani-Ancoma-Sorata Trail, down to Sorata, 13,000 ft, 20 Apr 1936, *Tate 783* (Holotype, NY!; isotypes, GH! LA! PH! US!; phototype, LA!).

Loose, densely branched perennials, 5.0–15.0 cm high. Shoots numerous, intertangled, ascending or shortly decumbent, rhizomatous, sending out adventitious roots from the lower nodes, hirtellous above with short, stiff, spreading hairs, puberulent below. Leaves spreading or ascending, membranous, ovate to obovate 3.5–5.0 mm (4.6 mm) wide, 5.0–8.0 mm (6.4 mm) long, margins in the upper half of the blade crenate, apex acute, the base rounded or cuneate with a small petiole, less than 0.5 mm long; surfaces glabrate to strigose above, strigose below and on the margins; nervation distinct. Cymules 1–4-flowered, occuring along the upper 1/2 of the stems but somewhat congested near the branch apices, peduncles inconspicuous; pedicels 2.0–3.5 mm long hirtellous; bracteoles subulate shorter than the pedicels they subtend, ca 1.5 mm long. Calyx 4.0–5.0 mm (4.7 mm) long; the tube 2.5–3.2 mm (3.0 mm) long, gibbous or saccate below for ca 1/2 of its length, 1.1–1.5 mm wide, puberulent or hirtellous with fine spreading hairs; the upper calyx teeth connate for ca 1/2 of their length forming an upper lip 1.2–1.6 mm long, the lobes deltoid to triangular, erect or slightly reflexed, 0.3–0.5 mm wide at the base, 0.6–1.0 mm long, hirsute-ciliate; the lower teeth, recurved, subulate, scarcely exceeding the upper lip in length, ca 0.4 mm wide at the base, 1.3–2.0 mm long, hirsute-ciliate; annulus included, very sparse, seated approximately at the juncture of the upper and lower lips, ca 0.5 mm wide. Corolla 6.0–8.5 mm long, glabrous within, the tube 5.0–6.5 mm long gradually dilating upwardly, ca 1.5 mm wide at the summit; the upper lip obcordate, deeply emarginate, straight and flat, ca 2.0 mm wide, 1.0–1.5 mm long; the lower lip not spreading, 3.0–4.0 mm wide, 2.0–2.5 mm long, the central lobe broadened and well-exserted from the laterals. Nutlets 0.8 mm wide, ca 1.0 mm long, black, the surface ruminate, not glaucous. Chromosome number, unknown.

Distribution (Fig. 12). Andes Mts. of southern Peru and northwestern Bolivia. 8000–14,000 ft. Jan–Jul.

TYPE: BOLIVIA. Province of La Paz, Cordillera de Sorata, 1858, *Mandon s.n.* (Holotype, P; phototype, LA!).

Hedeoma mandonianum is most closely related to *H. crenatum* of southern Brazil.

EXCLUDED NAMES

Hedeoma arkansana Nutt., Trans. Am. Phil. Soc. N.S. 5: 186. 1837. = *Satureja glabra* Fern.

Hedeoma angulata Tharp. = *Rhododon ciliatus* (Benth.) Epl.

Hedeoma bicolor (Wats) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 294. 1897. = *Poliomintha longiflora* Gray.

Hedeoma bracteolata Nutt., Gen. Am. 2: Add. 1818 = ? *Conradina* sp. (fide Epling).

Hedeoma caerulescens Benth. D. C. Prodr. 12: 245. Nov. 1848 = *Satureja caerulescens* Epl.

Hedeoma ciliata Benth. D. C. Prodr. 12: 245. Nov. 1848. = *Rhododon ciliatus* (Benth.) Epl.

Hedeoma coccinea (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 295. 1897. = *Rhabdocaulon coccineus* (Benth.) Epl.

Hedeoma denudata (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 295. 1897. = *Rhabdocaulon denudatus* (Benth.) Epl.

Hedeoma glabra Nutt., Gen. Am. 1: 16. 1818. = *Satureja glabra* Fern.

Hedeoma glabrescens (Gray) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 294. 1897. = *Poliomintha glabrescens* A. Gray.

Hedeoma glabrum Pers., Syn. 2: 131. 1807. = ? *Satureja glabrella* Briq. (fide Epling).

Hedeoma glaziovii Briq., Ann. Conserv. et Jard. Bot. Geneve 2: 185. 1898. = *Cunila galioides* Benth.

Hedeoma gracilis (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 295. 1897. = *Rhabdocaulon gracilis* (Benth.) Epl.

Hedeoma gracilis var. *albiflora* (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a, 295. 1897. = *Rhabdocaulon gracilis* (Benth.) Epl.

Hedeoma gracillima Jones, Contr. West. Bot. 15: 150. 1929. = *Satureja brownei* Briq.

Hedeoma graveolens Chapman ex Gray, Proc. Am. Acad. 8: 1873. = *Stachydeoma graveolens* Small.

Hedeoma greggii Briq., Ann. Conser. Jard. Bot. Geneve 1. 1897. = *Poliomintha longiflora* Gray.

Hedeoma hassleri Briq., Bull. Herb. Boiss. ser. 2, 7: 611. 1907. = *Cunila spicata* Benth.

Hedeoma incana Torr., Bot. U.S. Mex. Bound. Surv. 130. 1859. = *Poliomintha incana* (Torr.) A. Gray.

Hedeoma italianiae Wawra, Oestr. Bot. Zeitschr. 31: 70. 1881. = *Hesperozygis myrtoides* (St. Hill ex Benth.) Epl.

Hedeoma longiflora (Gary) Briq., Engler & Prantl, Nat. Pflanzenf. ed. 1, IV, 3a. 294. 1897. = *Poliomintha longiflora* A. Gray.

Hedeoma marifolia (Schauer) Briq., Engler & Prantl. Nat. Pflanzenf., ed. 1, IV, 3a. 294. 1897. = *Hesperozygis marifolia* (Schauer) Epl.

Hedeoma micrantha Regel, Gartenfl. 357. 1864. = *Mosla ocymoides* Hamilt.

Hedeoma napalensis Benth, Lab. Gen. et Sp., 367. 1834. = *Mosla ocymoides* Hamilt.

Hedeoma nitda (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 295. 1897. = *Hesperozygis nitda* (Benth.) Epl.

Hedeoma pulegioides (L.) Pers. β-mexicanum, Lab. Gen. et Sp., 366. 1834. = As *H. pulegioides* is unreported from Mexico, Bentham's β-mexicanum undoubtedly refers to another species; however the type was not located.

Hedeoma purpurea Kellogg. Proc. Calif. Acad. 5: 52. 1873. = *Satureja* sp. (fide Epling).

Hedeoma rabiacea (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 294. 1897 = *Eriothymus rubiaceus* (Benth.) Schmidt.

Hedeoma schwackeana Glaziou, Bull. Soc. Bot. Fr. 48, Mem. III, 557. 1911 = *Hesperozygis myrtoides* (St. Hill ex Benth.) Epl.

Hedeoma scutellarioides (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 294. 1897. = *Hoehnea scutellarioides* (Benth.) Epl.

Hedeoma scutellarioides var. *pilosa* (Schmidt) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 294–295. 1897. = *Hoehnea scutellarioides* (Benth.) Epl.

Hedeoma serpylloides Torr., Pac. R.R. Rept. 4: 123. 1856. = *Pogogyne serpylloides* A. Gray.

Hedeoma stenodonta Briq., Bull. Herb. Boiss., ser. II, 7, 612. 1907. = *Rhabdocaulon stenondontus* (Briq.) Epl.

Hedeoma subequale Epl., Bull. Torr. Bot. Club 74: 513. 1947. = *Satureja* (*Quardoquia*) *micromiroides* Briq.

Hedeoma taxana Cory, Rhodora 38: 405. 1936. = *Rhododon ciliatus* (Benth.) Epl.

Hedeoma thymoides Pers., Syn. 2: 131. 1806. = *Thymus serpyllum L.* (fide Bentham).

Hedeoma villosa (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 295. 1897. = *Rhabdocaulon lavanduloides* (Benth.) Epl.

Hedeoma villosa var. *lavanduloides* (Benth.) Briq., Engler & Prantl, Nat. Pflanzenf., ed. 1, IV, 3a. 295. 1897. = *Rhabdocaulon lavanduloides* (Benth.) Epl.

ACKNOWLEDGEMENTS

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TAXONOMY OF *TETRAGONOTHECA* (ASTERACEAE-HELIANTHEAE)

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Tetragonotheca was first proposed by Linnaeus in 1753 to accommodate a single epappose species, *T. helianthoides*, which had been collected in the Carolinas by Gronovius. The genus receives its name from the four large, valvate, outer involucral bracts which house the florets and their associated receptacular scales or palea.

Gray, in 1841, described the second known species, *Tetragonotheca ludoviciana.* Because it had somewhat different, epappose, achenes he originally placed this in a newly erected genus, *Halea.* This was subsequently transferred to *Tetragonotheca.*

Engelmann and Gray, in 1848, added a third species, *Tetragonotheca texana.* Buckley, in 1861, added the fourth species, *T. repanda*, although Gray subsequently reduced this to varietal status under *T. ludoviciana.* The present treatment accepts the specific status of *T. repanda* and notes its relationship to be with *T. texana* instead of *T. ludoviciana.* In short, we recognize four allopatric species for the genus. So far as known, they do not intergrade or hybridize in nature.

CHROMOSOME COUNTS

Turner (1959) was the first to report chromosome numbers of *Tetragonotheca,* finding $n = 17$ pairs in three of the species examined. Shortly thereafter he counted the fourth species (*T. helianthoides,* $n = 17$). Voucher for the plants concerned are listed in Table 1. All counts were made from meiotic material at late diakinesis. At this stage bivalents show, characteristically, two chiasmata (Fig. 1). Subsequent workers (Table 1) have also found these several taxa to be diploid with $n = 17$ pairs.

GENERIC RELATIONSHIPS

Most workers have placed *Tetragonotheca* in the tribe Heliantheae. Subtribal disposition has been somewhat more controversial. Both Bentham (1873) and Gray (1886) include it in the subtribe Verbesininae, as did Hoffmann (1893). Stuessy (1977), however, placed the genus in the subtribe Helianthinae.

Species from genera of yet other tribes have been inadvertently (or ignorantly) placed in *Tetragonotheca* (cf., excluded species), the most notable being *Guizotia abyssinica* (Coreopsideae) and *Rumfordia* (Melam-

SIDA 8(3): 296–303. 1980.

podineae). By inference, then, some relationship to these taxa may be postulated. It should be noted, however, that both *Guizotia* (Baagøe, 1974) and *Rumfordia* (Sanders, 1978) are but dubiously positioned in these tribes, having strong relationships with the Heliantheae.

It is our feeling that *Tetragonotheca* is relatively remote from any extant genus. Were it to have unspecialized, multiseriated involucral bracts, it would probably be positioned in the subtribe Helianthinae, near *Viguiera.*

ACKNOWLEDGEMENTS

In preparing distribution maps we have compiled records from those herbaria listed below (abbreviations according to Lanjouw and Stafleu, Index Herbariorum, Regnum Vegetabile 31: 1964). We are grateful to the institutes concerned for the loan of this material: the number of sheets borrowed, upon which the distributional maps are based, is shown in parenthesis.

ALA (5)	MO (94)*
DUKE (15)*	NC (62)*
FM (90)*	NY (92)*
FSU (29)*	SMU (82)
GH (100)*	TENN (41)
LAF (4)	TEX (100)
LL (50)	UC (29)*
MICH (27)*	US (122)*

This paper was originally begun in the early sixties by Mr. William L. McCart, graduate student at the University of Texas, Austin. Annotation of material from the above institutions marked with an asterisk (*) was undertaken at that time. Subsequent annotations have been made by the present authors.

Table 1. Chromosome counts in *Tetragonotheca.*

Species	Voucher* or reference	*n* number (pairs)
T. helianthoides	FLA. Alachua Co.: *Powell et al.* (1974)	17
	FLA. Columbia Co.: *Turner 4927.*	17
	FLA. Escambia Co.: *Turner 4919.*	17
	GA. Harris Co.: *Jones et al.* (1973)	17
	MISS. Lamar Co.: *Jones et al.* (1966)	17
T. ludoviciana	TEX. Montgomery Co.: *Turner* (1959)	17
T. repanda	TEX. Atascosa Co.: *Turner 4979.*	17
	TEX. Jim Hogg Co.: *Strother* (1972).	17
	TEX. Medina Co.: *Turner* (1959).	17
T texana	TEX. Travis Co.: *Turner* (1959).	17
	TEX. Travis Co.: *Urbatsch* (1974).	17

* On file, Plant Resources Center, Austin.

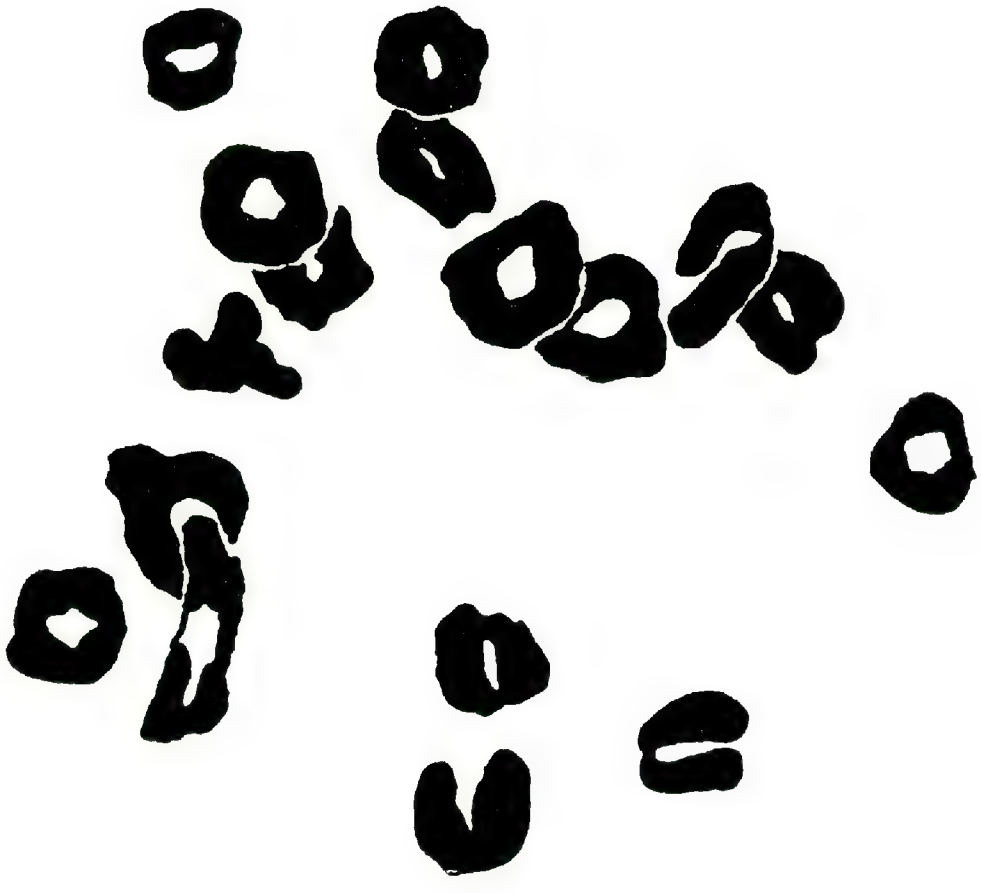

Fig. 1. Meiotic configuration at diakinesis in *Tetragonotheca helianthoides* (X 2600).

TETRAGONOTHECA L.

Tetragonotheca L., Sp. Pl. 2: 903. 1753.
Bikera Adans., Fam. 2: 130. 1763.
Gonotheca Raf., *in* Med. Repos. N. York 5: 352. 1808.
Halea T. & G., Fl. N. Amer. 2: 304. 1842.
Tetragonosperma Scheele, Linnaea 22: 166. 1849.

Coarse, erect, perennial, caulescent herbs with strong tap roots. Leaves opposite, simple, varying from nearly entire to coarsely-toothed to somewhat pinnatifid, their sessile bases often connate-perfoliate. Heads large, solitary, the disk and ray flowers yellow. Involucre double, the outer of 4 large, ovate phyllaries which are valvate in bud and remain united below forming a 4-angled or winged cup; the inner phyllaries membranous, as many as the ray flowers, and partly enclosing their achenes. Receptacles convex or conical, with narrow, membraneous chaff. Ray flowers pistillate, fertile. Disk flowers perfect, fertile. Style branches flattened, with marginal, stigmatic lines, the apices with an elongate hispid appendage. Achenes

quadrangular to sub-terete, truncate or rounded at the summit; pappus wanting or of several to numerous small, short scales. Basic chromosome number, $x = 17$ pairs. Type species: *Tetragonotheca helianthoides* L.

Key to species of *Tetragonotheca*

1. Pappus of 16 or more well-developed scales; plants of deep sandy soils in eastern and southern Texas.
   2. Leaves mostly basal, those on the main stem few, remote, and much reduced; peduncles stout, elongate, 5–40 cm long; plants of southern Texas ..... 3. *T. repanda*
   2. Leaves not mostly basal, those on the main stem well-developed, markedly perfoliate, the blades usually overlapping; peduncles 2–12(15) cm long; plants of eastern Texas ..... 2. *T. ludoviciana*
1. Pappus absent or a poorly developed fringe of ciliate scales (rarely comprised of 15 or fewer lacerate or fimbriate scales up to 1.0 mm long); plants of the southeastern U.S. or of calcareous soils in south-central Texas and adjacent Mexico.
   3. Mid-stems leaves mostly 1–3(4) cm wide, markedly perfoliate-auriculate; involucral bracts mostly 8–15 mm long; plants of Texas and adjacent Mexico ..... 4. *T. texana*
   3. Mid-stem leaves (3)4–8 cm wide, not perfoliate; involucral bracts mostly 15 mm long or more; plants of the southeastern U.S. (east of the Mississippi River) ..... 1. *T. helianthoides*

1. TETRAGONOTHECA HELIANTHOIDES L. Sp. Pl. 2: 903. 1753. Type: VIRGINIA. *Gronovius 301.* Phototype (GH!)

Gonotheca helianthoides (L.) Raf., Med. Repos. N. York 5: 352. 1808.

Perennial herbs from stout tap roots. Stems commonly tufted, 3–10 cm tall, densely pubescent with crisp, spreading hairs (rarely glabrate or villous). Leaves broadly ovate to elliptical, sessile, mid-stem blades 5–20 cm long, 4–10 cm wide, acute or acuminate at the apex, remotely but sharply toothed or merely crenulate to nearly entire. Heads, excluding the rays, 2–4 cm across. Peduncles 5–8 cm long. Involucral bracts broadly ovate, 2–3 cm long, 1–2 cm wide. Ray florets 8–13, the ligules yellow, 2–4 cm long, 0.5–1.0 cm wide; tube 6–8 mm long, pubescent with spreading hairs. Disc florets greenish yellow; tube 1.5–2.0 mm long, sparsely to densely, crisp-spreading pubescent; throat 4–5 mm long. Achenes broadly clavate, turgid, subterete to somewhat 5(4)-sided, 4–6 mm long, striate, glabrous, epappose. Chromosome number, $n = 17$ II.

DISTRIBUTION AND ECOLOGY (Fig. 2). Mostly in sandy soils of cut-over pine and oak woodlands; southeastern United States, not known west of the Louisiana River. Flowering Apr–Aug.

Except for its vestiture, the species is remarkably uniform considering its wide distribution. On both morphological and chemical grounds (Urbatsch, pers. comm.), *T. helianthoides* seems closest to *T. ludoviciana*, ancestral populations from which it was presumably derived through regional isolation, loss of pappus and numerous other small but, in consort, significant diagnostic features.

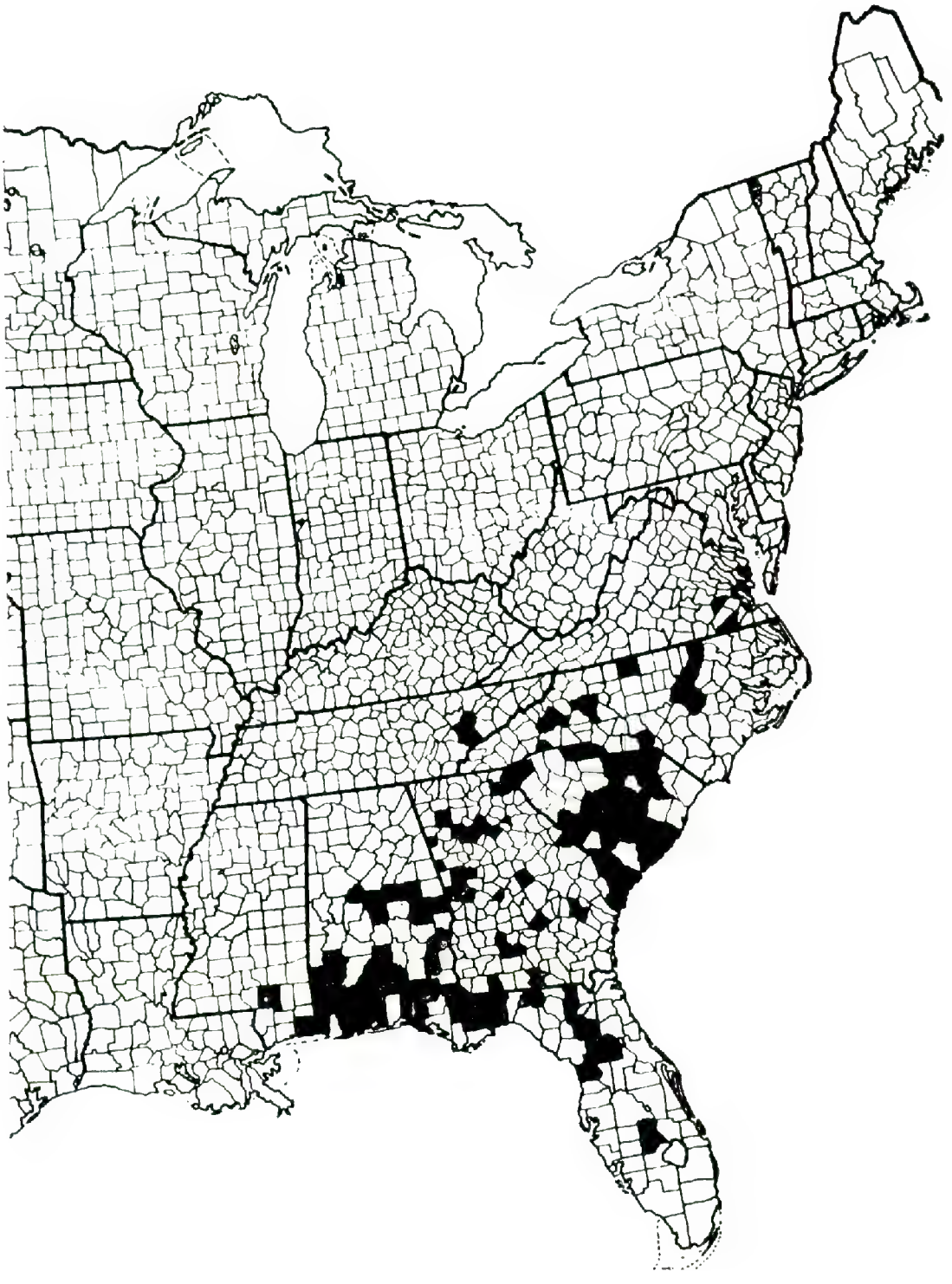

Fig. 2. Distribution, by county, of *Tetragonotheca helianthoides*.

2. TETRAGONOTHECA LUDOVICIANA (T. & G.) Gray ex Hall, Pl. Texanae 13. 1873.

Halea ludoviciana T. & G., Fl. N. Amer. 2: 304. 1841. Type: LOUISIANA. "Western Louisiana." Dr. *Leavenworth s.n.* (apparently collected before Jun 6, 1837, according to notation on the holotype). Holotype (NY!).

Perennial herbs from stout, elongate tap roots. Stems mostly single but sometimes tufted, especially following injury, densely white villous to glabrous. Leaves broadly triangular-ovate to somewhat repand, especially below, the mid-stem leaves nearly always connate or perfoliate, irregularly coarsely dentate to crenulate. Heads, excluding the rays, 1.5–3.5 cm across. Peduncles mostly short, slender, 2-8(12) cm long. Involucral bracts ovate, 1.0–1.8 cm long, 0.8–1.2 cm wide. Ray florets mostly 13, the ligules yellow, 1.0–1.8 cm long, 0.5–0.7 cm wide; tube 4–5 mm long, glabrous to sparsely pubescent. Disc florets yellow; tube ca 1.5 mm long, sparsely pubescent; throat 4–5 mm long. Achenes 4.5–6.0 cm long, 5(6)-sided, sparsely appressed pubescent; pappus a crown of 20–30 short, thickened, entire or erose, scales, 0.5–1.5 mm long. Chromosome number, $n = 17$ II.

DISTRIBUTION AND ECOLOGY (Fig. 3). Deep sandy, usually sterile, white soils of southeastern Texas and adjacent Louisiana. Flowering, Apr–Aug.

3. TETRAGONOTHECA TEXANA Gray & Engelm., Proc. Amer. Acad. 48. 1848. Type: TEXAS. Guadalupe Co.: Hills between the Guadalupe and Cibolo rivers, 12 mi W of New Braunfels, according to label data (MA), Apr 1846, *F. Lindheimer 431.* (Holotype, GH!; isotypes MO!, NY!, UC!, US!).

Halea texana (Gray & Engelm.) Gray, Proc. Amer. Acad. 83. 1849.
Tetragonosperma lyratifolium Scheele, Linnaea 22: 166. 1849. Type: TEXAS. Guadalupe Co.: Rocky soil, Cibolo River, Apr–May 1846? *Roemer s.n.* (Holotype, B).

Perennial herbs from tough tap roots. Stems mostly slender, solitary or tufted, only moderately branched above, 3–6(7) dm tall, frequently tinged with maroon, finely pubescent to glabrate. Leaves oblong, oval or elliptic in outline, pinnatifid, incised or repand, the lower-most merely connate, the upper connate-auriculate, 3–10 cm long, 2–4 cm wide. Heads, excluding the rays, 1–2 cm across. Peduncles elongate, slender, (8)10–25 cm long. Involucral bracts 1.0–1.5 cm long, 1.0–1.4 cm wide. Ray florets 8–13, the ligules yellow, 4–5(6) mm wide; tube ca 4 mm long. Disc florets yellow; tube ca 1 mm long, glabrous; throat ca 4 mm long. Achenes, obpyramidal, 3–4 mm long, pubescent, eppapose or sometimes with 4–12 small, ciliate scales. Chromosome number, $n = 17$ II.

DISTRIBUTION AND ECOLOGY (Fig. 3). Calcareous, rocky soils, or sometimes in mixed gravelly stream bottoms of south central Texas, extending into north central Mexico. Flowering Apr–Oct., depending on rains.

4. TETRAGONOTHECA REPANDA (Buckl.) Small, Fl. Southeastern U.S. p. 1250, 1340. 1903.

Helea repanda Buckl., Proc. Acad. Nat. Sci. Phila. 458. 1861. Type: TEXAS. Nueces Co.: "near Corpus Christi:" May w/o year, *Buckley s.n.* (Holotype, PH!).
Halea ludoviciana var. *repanda* (Buckl.) Gray, Syn. Fl. N. Amer. 2: 256. 1884.

Perennial herbs from stout, elongate, tap roots. Stems 1–5 dm tall at first single but soon forming a short bushy habit through the production of stout laterals from the root-crown, minutely soft pubescent, particularly at the base and below the nodes. Leaves irregularly dentate, 3–12 cm wide,

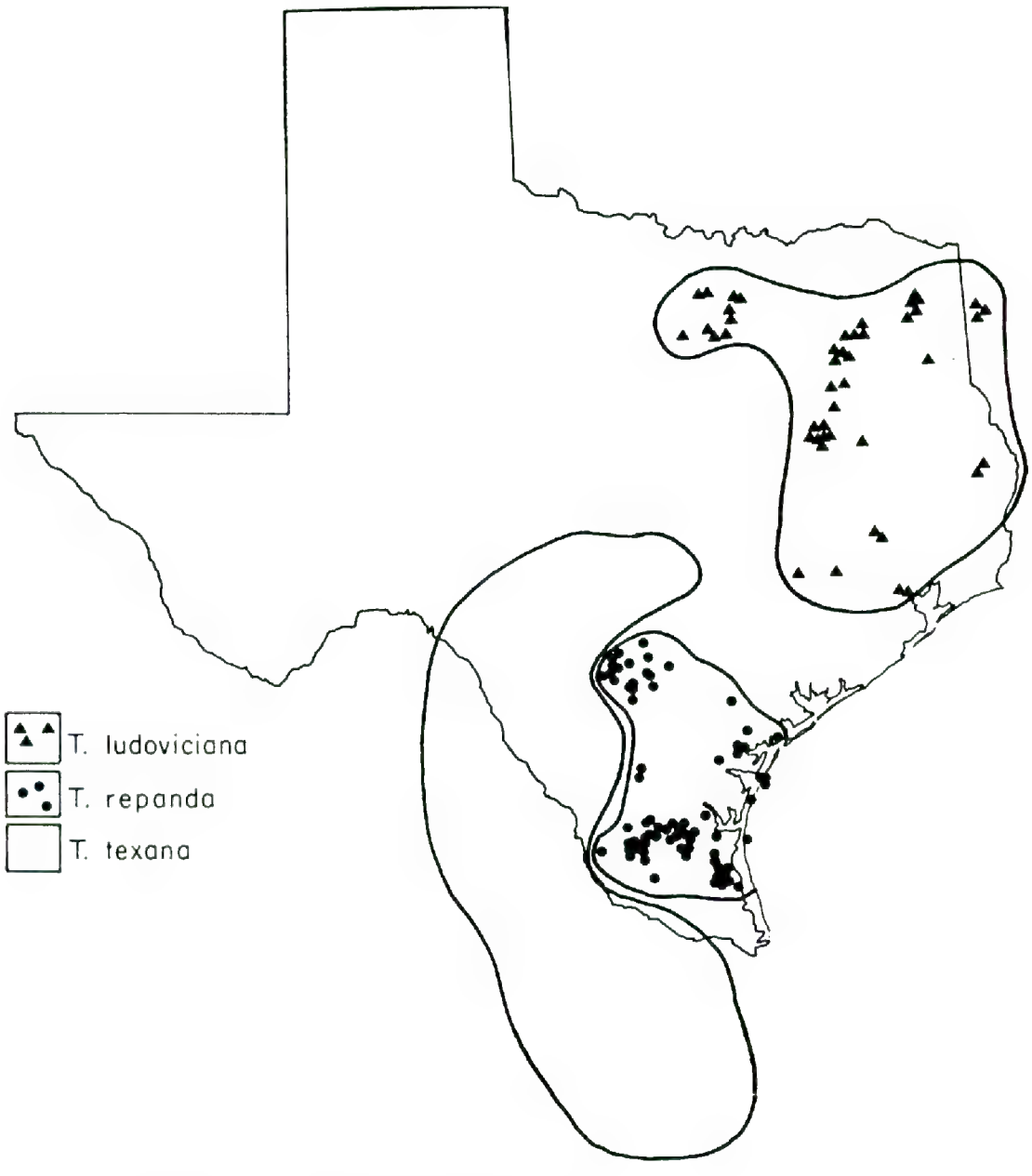

Fig. 3. Distribution of *Tetragonotheca* species.

12–24 cm long; blades of the rosette triangular with slender petioles; stem-leaves ovate, lanceolate to repand, narrowed into petiolar-like bases. Heads, excluding the rays, mostly 1.5–2.5 cm across. Peduncles stout, (5)10–40 cm long. Involucral bracts ovate to triangular-ovate, 1.1–2.0 cm long, 1.0–1.8 cm wide. Ray florets 16–24, golden-yellow, the ligules 2–3 cm long, 0.5–0.8 cm wide; tubes 5–6 mm long. Disc florets yellowish-green; tube glabrous to sparsely pubescent, 1–2 mm long; throat 4–5 mm long. Achenes 4.7–5.5 mm long, turgid, 4(5) sided, sparsely hispid-pubescent, especially along the angles; pappus a crown of 20–30 entire or erose scales, 0.3–1.5 mm long, those of the ray about 1/3 as long as those of the disc. Chromosome number, $n = 17$. II.

DISTRIBUTION AND ECOLOGY. (Fig. 3). Deep sandy soils of southern Texas and possibly adjacent Mexico. Flowering Mar–Nov., depending on rains.

Gray treated the species as a variety of *Tetragonotheca ludoviciana* but, as noted by Urbatsch *et al.* (1978; unpubl.), on chemical grounds it is closest to *T. texana*. It is also similar to the latter morphologically. In fact, occasional roseate or mowed plants of *T. texana* may be taken for *T. repanda*, but these can be readily identified by their epappose or fimbriate scales of the achenes, by their smaller leaves and generally slender stems.

Excluded Species

Tetragonotheca abyssinica Ledeb, Ind. Sem. Hort. Dorpat Suppl. 1824. = *Guizotia abyssinica* L. f. (Cf. Baagøe, 1974).

Tetragonotheca parviflora Jacq., Enum. Pl. Carib. p. 28, 1760 (from description and locality apparently not a *Tetragonotheca*).

Tetragonotheca guatemalensis Coulter, Bot. Gaz. 16: 99. 1891. = *Rumfordia guatemalensis* (Coult.) Blake, Wash. Acad. Sci. 18: 25. 1928 (Cf. Sanders, 1978).

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NEW SPECIES OF *CLITORIA* SUBGENUS *BRACTEARIA* SECTION *BRACHYCALYX* (LEGUMINOSAE) FROM COLOMBIA, VENEZUELA, AND BRAZIL[1]

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Members of *Clitoria* L. subgenus *Bractearia* (Mart. ex Benth.) Fantz section *Brachycalyx* Fantz are characterized by short tubular to cup-shaped calices with minute lobes, inflorescences emerging from denuded nodes earlier than the appearance of the leaves, fruits which become slightly convex around the seeds and are conspicuously depressed between the seeds at maturity, deciduous leaves, and usually an erect habit (trees or tall shrubs). Section *Brachycalyx* includes seven species (Fantz, 1979): *Clitoria brachystegia* Benth., *Clitoria brachycalyx* Harms, *Clitoria glaberrima* Pittier, *Clitoria dendrina* Pittier, and the three species newly described below.

1. CLITORIA **hermannii** Fantz, sp. nov.

Frutex ad 2 m altus. Folia trifoliata, *foliola suborbiculata vel late ovalia*, obtusa et abrupte minute acuminata, *supra trichomatibus brevibus mollibus appressis, subter* velutinis. *Inflorescentia 1.5–2 cm longa*, axillaris a nodis denudatis ante foliis primum crescens, subpaniculata, ramis primaris lateralibus pedicellos praeditis ad 4 mm longis. *Flores* resupinati, albi, *4.8–5.2 cm. Calyx* brevitubularis, dense appresso-pubescens; *tubus 11–13 mm longis*; lobi breves, 3–4 mm longi. Vexillum extus fulvo-sericeum. *Tubus staminalis* 24–26 mm, *apice trichomatibus uncinatis*. Legumen incognitum.

Erect shrub to 2 m tall. Branches solid, pubescence moderately dense with short, appressed to suberect trichomes; axillary buds 3–3.5 mm. *Leaves* 3-foliate, subcoriaceous, leaflets suborbicular becoming broadly oval when expanded, apex obtuse, abruptly minutely acuminate, base weakly cordate to rotund, midrib impressed above, primary nerves of 8–10 pairs, upper surface soft pubescent, trichomes short (ca 0.5 mm), appressed, lower surface velutinous, juvenile leaflets 4–7 cm in diameter, lamina expanding to 10–12 cm long by 7–9 cm wide. Petiole elongate, 6.5–15 cm, pubescence dense, appressed; rachis (1.5) 2–2.5 cm; petiolules quadrangular, tomentose, 5–8 mm. Stipules caducous (?– not observed); stipels caducous,

[1] Taxonomic studies on *Clitoria* accomplished at the IFAS Herbarium, Dept. of Botany, The University of Florida, Gainesville, Florida. Florida Agricultural Experiment Station Journal Series No. 1346.

SIDA 8(3): 304–311. 1980.

linear, acute, 3-nerved, 2–2.5 mm long, 0.5 mm wide, sparsely pubescent. *Inflorescence* axillary, multiflowered, at denuded nodes appearing earlier than the leaves, subpaniculate with primary lateral branches which bear the pedicels subsessile to 4 mm long; axes crowded toward branch apices, pubescence dense; central axis 1.5–2 cm long; pedicels 5–7 mm. Bracts persistent, 1.5–2 mm long, 1 mm wide, pubescence dense, appressed. Bracteoles minute, ovate to suborbicular, obtuse, 2–3 mm long, 2 mm wide, pubescence appressed, dense. *Flowers* resupinate, white, 4.8–5.2 cm. Calyx short-tubular, pubescence dense, appressed, tube 11–13 mm long, 5–6 mm wide at base expanding to 8–9 mm wide at throat, lobes minute, broadly ovate-deltoid, 3–4 mm long, 2–2.5 mm wide, ventral lobe 4–5 mm long. Vexillum with indumentum on dorsal surface dense, appressed, tawny, blade ca 3 cm wide, claw broadly cuneate, 8–9 mm long. Alae extended well beyond carina by 6–9 mm, blade 19–23 mm long, 6–10 mm wide, claw 12–15 mm. Carina blade falcate, 10–12 mm long, 4 mm wide, claw 21–24 mm. Staminal tube 24–26 mm long, uncinate-pubescent near apex, vexillary stamen coherent near middle of tube, free above and below, free filaments 2–5 mm long; anthers lanceolate, 2–2.5 mm long, 0.5 mm wide, connective apiculate. Gynophore 5 mm, with a few spreading white trichomes near apex; ovary 14–15 mm long, 1.3 mm wide, pubescence white slightly tinged yellowish, dense; style bearded, 16–17 mm, geniculate 7–8 mm; stigma subcapitate, 0.5 mm in diameter. *Legume* unknown. Fig. 1.

TYPE COLLECTIONS: COLOMBIA. Vichada: shrub 18 in., almost leafless, fl. white, grassy llanos, along Rio Vichada, San José de Ocuné, 100 m, 19 Jan 1944, *Hermann 10994* (HOLOTYPE: NY. ISOTYPE: GH). PARATYPES: COLOMBIA. Vichada: 6 km NE of Masaquara on llanos along Rio Vichada, ca 36 km NE of San José de Ocuné, 100 m, 21 Jan 1944, *Hermann 11019* (NY, US 1879110).

Clitoria hermannii appears similar to *C. dendrina* and *C. brachycalyx* in its vegetative aspects, but the larger flowers, smaller stipels, and other morphological comparisons indicate closer affinities with *Clitoria brachystegia* of Ecuador, which is easily distinguished from *C. hermannii* by the elongated inflorescences (5–22 cm) and acuminate leaflets which are pilose below. All known collections of this species are from localities near San José de Ocuné, Colombia.

2. CLITORIA **canescens** Pittier ex Fantz, sp. nov.

Clitoria canescens Pittier, *nom. in sched.*

Frutex. Folia trifoliata, *foliola lanceolata-elliptica,* acuminata, *supra glabra,* subter super nervis trichomatibus inconspicuis, appressis. Inflorescentia 1.5–3.5 cm vel longior (? apex effractus), racemoso-nodosa vel subpaniculata, pedicelli super axe centrali ex toris lignosis portati vel aliquando super ramis primariis lateralibus ad 6–7 mm longis portati. Flores parva, resupinati, 3.5 cm. *Calyx* brevitubularis, *canescens, tubus 13–15 mm,* lobi 3–4 mm. *Vexillum extus canescens,* praesertum in albastro. *Tubus staminalis glaber,* 28 mm longus. Legumen incognitum.

Shrub. Branches subterete, solid, internodes in weak zigzag pattern, ju-

venile branches with pubescence uncinate (vidi 30X) plus scattered, short, appessed trichomes (vidi 10X), becoming glabrous; axillary buds 3 mm. *Leaves* 3-foliolate, coriaceous, leaflets lanceolate-elliptic, apex acuminate, base broadly cuneate, midrib impressed above appearing as if it is in a shallow groove, primary nerves of 9–10 pairs, upper surface faintly glossy,

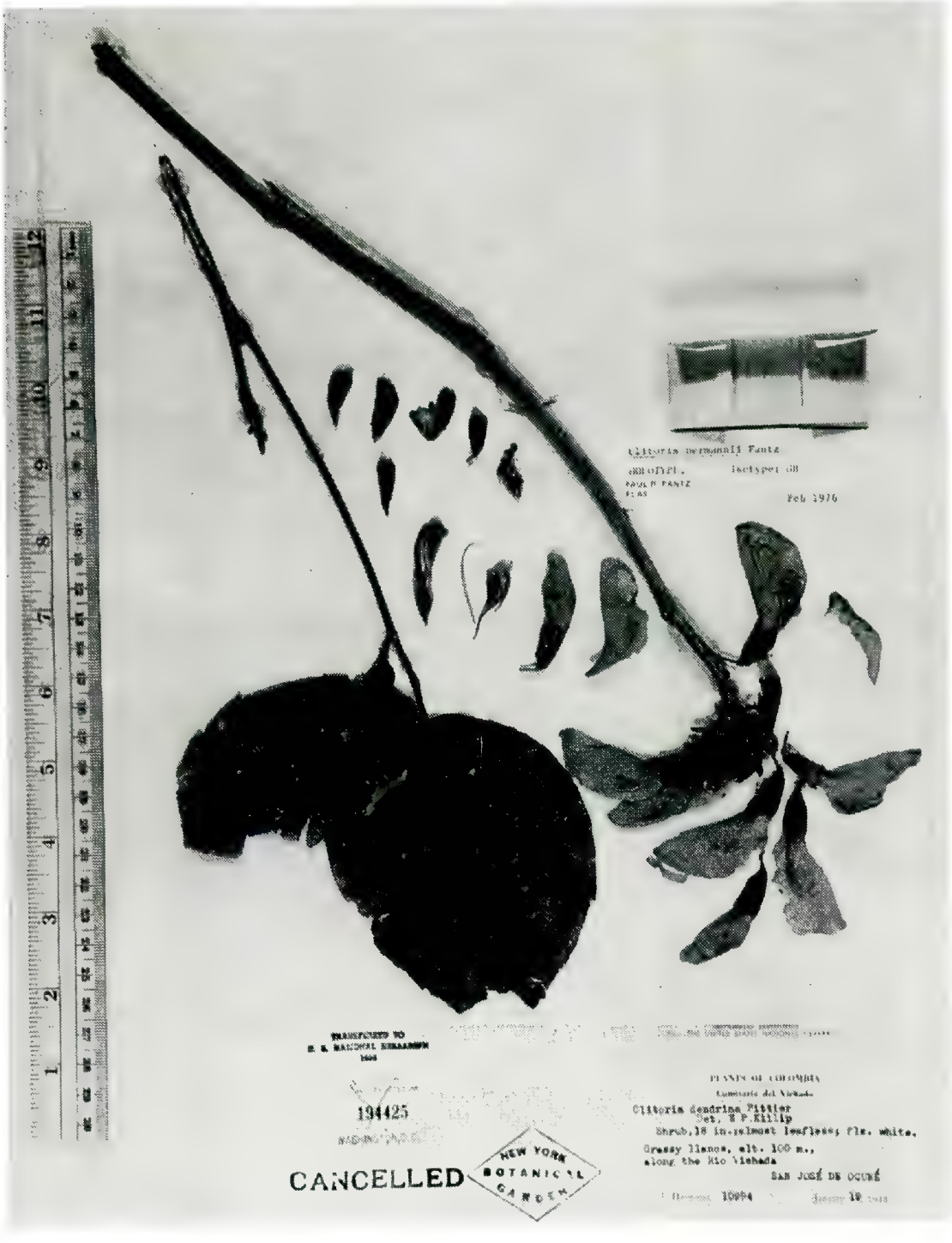

Figure 1. Holotype of *Clitoria hermannii* (*Hermann 10994*, NY).

glabrous, lower surface dull, pubescence on nerves, inconspicuous, short, appressed, lamina 15–17 cm long, 6–7 cm wide. Petioles subquadrangular-terete, 9 cm; rachis 3.5 cm; petioles subquadrangular, rugose, glabrate, 8–10 mm. *Inflorescence* terminal, racemose-nodose to subpaniculate, pedicels borne on central axis at lignose knobs or occasionally on a primary lateral branch of 6–7 mm; axes compressed laterally, subquadrangular, twisting, pubescence moderately dense, appressed; central axis 1.5–3.5 cm long or possibly longer (apex broken); pedicels strigose, 6 mm. Bracts minute, ovate, acute, strigose, 1–2 mm long, 0.5–1 mm wide. Bracteoles minute, ovate, acute to short-acuminate, 2–3 mm long, 1–1.5 mm wide, strigose. *Flowers* resupinate, small, 3.5 cm, purple (?–in dry state the appearance is similar to *C. dendrina* which has purple flowers). Calyx dark-colored, with short-appressed trichomes (buds densely pubescent, canescent), tube short, 13–15 mm long, 4–5 mm wide at base expanding to 7 mm at the throat, lobes minute, broadly deltoid, short-acuminate, 3–4 mm long, 2.5–3 mm wide at base, ventral lobe linear, 6 mm long, 0.5–0.7 mm wide. Vexillum with indumentum on dorsal surface dense, canescent, appressed, blade obovate, 1.5 cm wide, claw 6–7 mm long, cuneate. Alae extended beyond the carina by 4–5 mm, blade 17 mm long, 3–5 mm wide, claw 16 mm. Carina blade falcate, acute, 16 mm long, 4–5 mm wide, claw 20 mm. Staminal tube glabrous, 28 mm long, free filaments 3–5 mm; anthers 3 mm long, 0.5 mm wide. Gynophore 3 mm long, brownish-black, moderately densely sericeous, white trichomes; ovary 13 mm long, 1 mm wide, black with very dense pubescence, trichomes white, sericeous; style black near base and sericeous, bearded above, 18 mm long, geniculate 3–4 mm; stigma compressed, 0.5 mm in diameter. *Legume* unknown. Fig. 2.

TYPE COLLECTION: VENEZUELA. Amazonas: sitios arenoso de la boca del Gahama, Cäno S. Miquel, Guiama, alto Rio Negro, 26 Mar 1942, *Williams 14893* (HOLOTYPE: VEN 4038).

The type specimen bears the name "*Clitoria canescens* Pittier, sp. n." typed on the label and is placed in a separate type folder bearing this name. No record of the publication of Pittier's name has been found. Pittier (1944) did not include this species in his key to the species of *Clitoria* in Venezuela.

Dried flowers of this species morphologically suggest *Clitoria dendrina* more than any other species in the genus, although *C. canescens* can be distinguished easily by the canescent vexillum and calyx tube (especially during the bud stage), longer calyx tubes, longer style, and the sparse pubescence of the leaves. In addition, the inflorescences are less crowded with flowers and occasionally bear primary lateral branches, the ovary lacks any yellowish pigmentation, and other floral structures differ in their measurements. *Clitoria canescens* is known only from the type locality.

3. CLITORIA **froesii** Fantz, sp. nov.

Frutex caulibus scandentibus. Folia trifoliata, *foliola lata ovata vel late ovalia vel*

Figure 2. Holotype of *Clitoria canescens* (*Williams 14893*, VEN 4038).

late oblongata, acuminata, supra hirsuta, subter pilosa. Inflorescentia 1.5–3 cm, pauciflora. Flores resupinati, parvi, 3.5–4 cm. *Calyx* brevitubularis, *tubus 12–13 mm*, dense appressopubescens, lobi 3–4 mm. Vexillum extus sericeum. *Tubus staminalis glaber*, 24–28 mm, *antherae* 2.4–3 mm, *connectivo longo-apiculato.* Legumen incognitum.

Liana. Branches 3–9 mm in diameter, solid becoming hollow in larger diameter branches, juvenile branches longitudinally striated, angular-terete, pubescence densely uncinate (vidi 30X) beneath the erect to appressed macrotrichomes (vidi 10X), the latter deciduous with age, mature branches becoming glabrate; axillary buds 5 mm. *Leaves* 3-foliolate, thick-membranaceous, conspicuously pubescent, leaflets slightly asymmetrical, broadly ovate to broadly oval or broadly oblong, apex acuminate, acumen to 1.5 cm long, base rotund, midrib and some of the basal primary nerves weakly raised above, midrib densely pubescent, primary nerves of 7–11 pairs, upper surface dark green, minutely hirsute, texture similar to fine sandpaper, lower surface light green, pilose, nerves densely pilose-hirsute, lamina 10–25.5 cm long, 7–16.5 cm wide. Petioles elongate, 13–24 cm, subterete, trichomes dense, erect; rachis 4–6.5 cm; petiolules 5–7 mm, quadrangular, trichomes dense, erect, tawny. Stipules caducous, lanceloate, acute, 4–7 mm long, 2 mm wide on juvenile branches to 10 mm x 3 mm on more robust branches; stipels caducous, linear, acute, weakly 3-nerved, 3–6 mm long, 0.5–1 mm wide. *Inflorescence* axillary and terminal, racemose-nodose; axes solitary, occasionally branched near base, few flowered, 1.5–3 cm, trichomes dense, erect; pedicels 6–7 mm. Bracts minute, ovate, acute, 2–3 mm long, 2 mm wide, densely pubescent. Bracteoles ovate, acute, 3–4 mm long, 2 mm wide, densely pubescent. *Flowers* resupinate, small, 3.5–4 cm. Calyx pubescence dense, appressed, tube short, 12–13 mm long, 4–6 mm wide at the base expanding to 7–9 mm wide at the throat, lobes minute, deltoid, acute, (3) 4 mm long, 2 mm wide, ventral lobe subequal, 1–1.5 mm wide. Vexillum with indumentum sericeous on the dorsal surface, blade 2.5 cm wide, claw 4–6 mm. Alae extended beyond the carina by 4–6 mm, blade 18–21 mm long, 4–8 mm wide, claw short, 7–9 mm. Carina falcate, 9–13 mm long, 4 mm wide, claw 12–16 mm. Staminal tube glabrous, 24–28 mm long, vexillary stamen coherent below to near the middle, free filaments 2–4 mm long; anthers lanceolate, 2.4–3 mm long, 0.5–0.8 mm wide, connective long-apiculate. Gynophore 2–3 mm; ovary 10–11 mm long, 1.2–1.3 mm wide, pubescence dense, white; style 14–15 mm, bearded, geniculate 6 mm; stigma capitate, 0.5 mm in diameter. *Legume* unknown. Fig. 3.

TYPE COLLECTIONS: BRAZIL. Amazonas: terra firma, Macubeta on Rio Maria, basin Rio Negro, 31 Jan 1942, *Fróes 12441/185* (HOLOTYPE: NY-Hb. Krukoff. ISOTYPE: A). PARATYPE: BRAZIL. Amazonas: Pirapuca on Rio Negro, 1941, *Froés 12431/175* (S-Hb. Erik Wall).

Clitoria froesii is the only species of section *Brachycalyx* with a climbing

habit, but the short calyx with minute lobes, the pubescence on the upper surface of the leaflets, and the lack of cauliflorous flowers suggest that this species should be assigned to section *Brachycalyx* rather than section *Cauliflorae* which is characteristically composed of species with a climbing

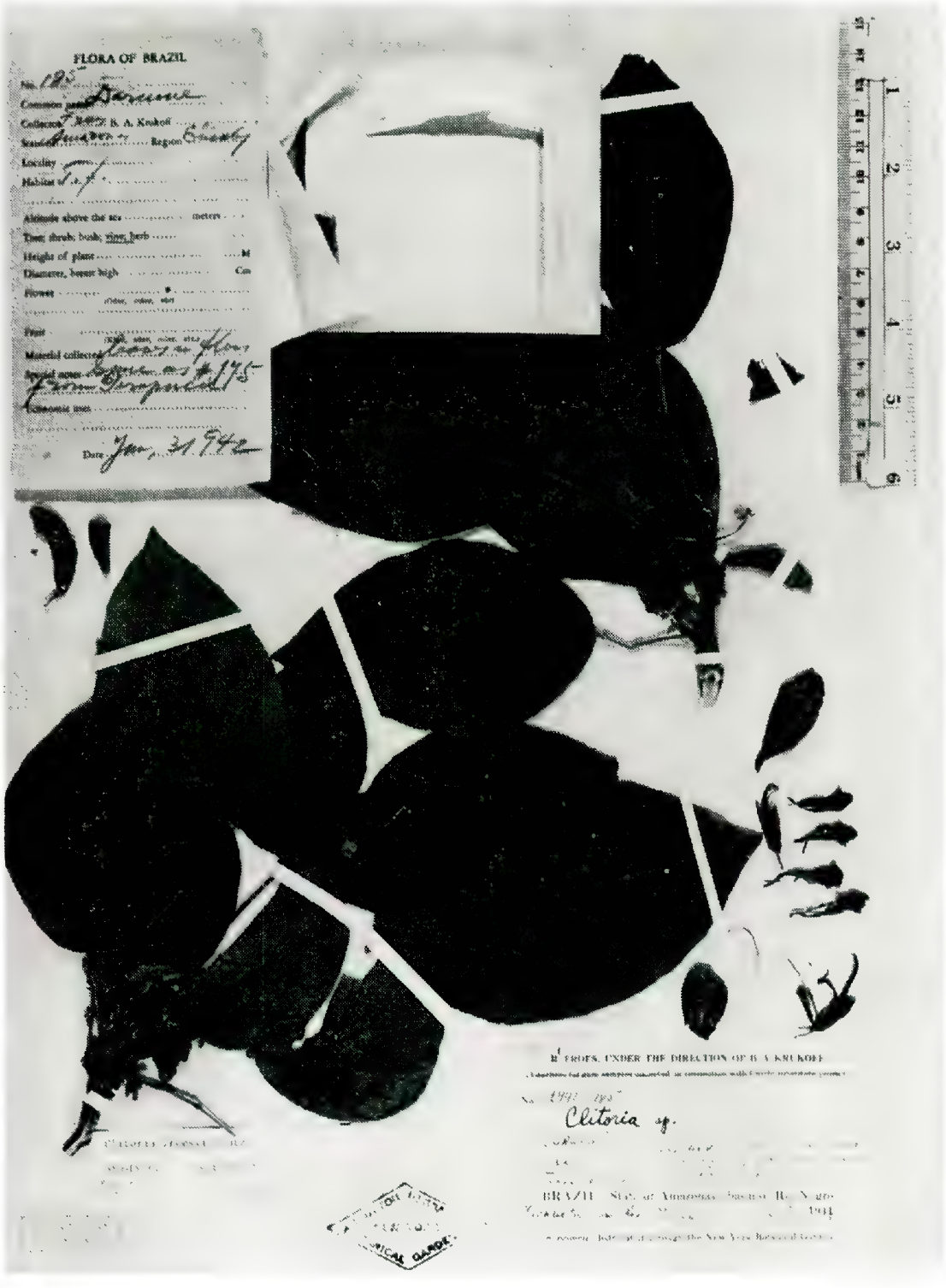

Figure 3. Holotype of *Clitoria froesii* (*Froes 12441/185*, NY).

habit. *Clitoria froesii* has close affinities with *Clitoria dendrina* which is distinguished by the arboreal habit, smaller calyx, smaller anthers, more crowded inflorescences, and leaflets which are velutinous below and broadly ovate to rhombic-ovate to orbicular. *Clitoria froesii* is known only from western Amazonas, Brazil.

Fróes noted that the local Indians call this plant "Darume Vine" and plant it in fair quantities, considering it to be the most toxic plant in the region of the Rio Icana. Fróes does not indicate for what purpose the toxin is used by the Indians. Other South American species of *Clitoria* are known to produce toxic seeds which are used locally as a fish poison.

Acknowledgement is made to Helen Correll for the Latin descriptions, and to Daniel B. Ward, Dana Griffin III, and Donovan Correll for reviewing the manuscript and providing constructive criticisms.

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NOTES

A CHROMOSOME COUNT FOR *JUNIPERUS ASHEI* (CUPRESSACEAE) AND ADDITIONAL CHROMOSOME NUMBERS FOR *HEDEOMA* (LABIATAE)—In a study of possible hybridization in *Juniperus*, some years ago, I was able to establish a chromosome record for *Juniperus ashei* Buchholtz. To my knowledge this is the first documented chromosome report for this species. The count was taken from root tip material using excised embryos grown on nutrient enriched agar. With this technique no pretreatment (stratification) of the seed material was necessary.

During recent biosystematic studies of *Hedeoma* and allied genera (Irving *et al.*, 1979) additional chromosome numbers were established for three previously uncounted taxa. These counts, derived from root tips, supplement *Hedeoma* chromosome numbers reported earlier (Irving, 1976). The numbers for *H. montanum* and *H. nanum* var. *macrocalyx* ($2n = 36$) are consistent with those of related taxa. *H. multiflorum* of Uruguay and Argentina, however, was tetraploid ($2n = 72$) but is closely related to *H. drummondii* ($2n = 36$) of Mexico and western U.S.

JUNIPERUS ASHEI Buchholtz (Fig. 1) $2n = 22$. U.S.A., Texas, Hays Co.: *R. S. Irving s.n.* (MONTU).

HEDEOMA MONTANUM Brandegee $2n = 36$. MEXICO, Coahuila, Sierra de Parras: *R. S. Irving* 77-7 (TEX).

HEDEOMA NANUM (Torr.) Briq. var. MACROCALYX Stewart, $2n = 36$ U.S.A., Ariz., Yavapi Co.: *R. B. Oxford 428* (ASU).

HEDEOMA MULTIFLORUM Benth. $2n = 72$. URUGUAY, Mercedes: *R. S.*

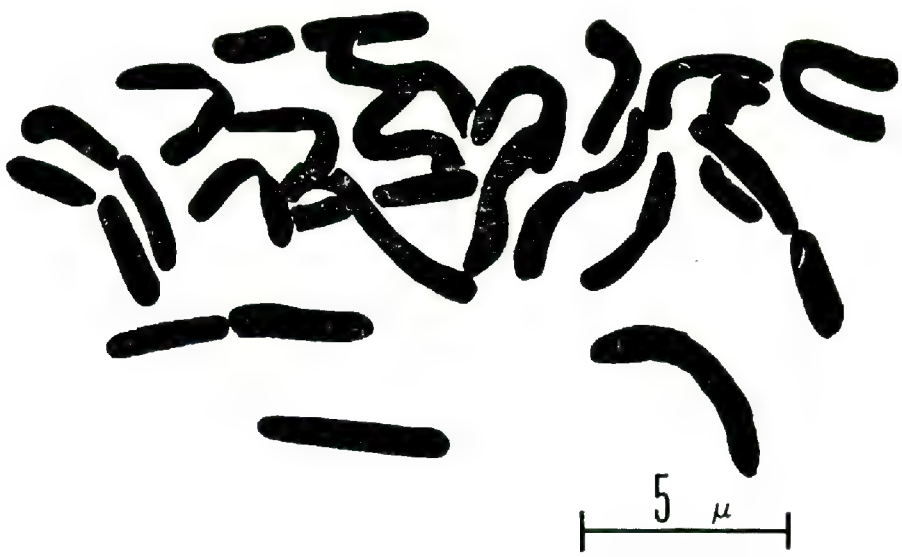

FIGURE 1. Chromosomes of *Juniperus ashei*. Tracing from photomicrograph.

Irving 7715 (TEX).—*Robert S. Irving, 1422 Summit, Little Rock, AR 72202.*

REFERENCES

IRVING, R. S. 1976. Chromosome numbers in *Hedeoma* (Labiatae) and related genera. Syst. Bot. 1: 46–56.

———, S. BRENHOLTS, & D. D. IRVING. 1979. Artificial hybridization in *Hedeoma* (Labiatae). Syst. Bot. 4: 1–15.

NEW AND RE-INSTITUTED COMBINATIONS IN *GUTIERREZIA* (COMPOSITAE: ASTEREAE).—In connection with monographic work on what is commonly known as the *Xanthocephalum* complex, and treatment of these genera for the *Flora of the Chihuahuan Desert Region* (M. C. Johnston, and collaborators, in preparation), the combinations listed below are necessary. Justification of such dispositions and full synonymy will be provided in a forthcoming doctoral dissertation on the group.

There is strong morphological and chromosomal evidence supporting the close alliance of the species of the former genus *Greenella* with those of *Gutierrezia*, reflected here by the transfer of *Greenella arizonica* and *G. ramulosa* into *Gutierrezia*. The third species of *Greenella, G. discoidea* Gray (Proc. Amer. Acad. Arts 19: 2. 1883), which is known only by the type material, has been found by this author to be a rayless form of *Xanthocephalum wrightii* (Gray) Gray. Since I have here returned this latter species to *Gutierrezia* also, the genus *Greenella* as a whole is reduced to synonymy. The only objection that Gray himself had to this placement was ray-floret color, and since there are several South American gutierrezias with white rays, maintenance of a distinct genus on that basis is meaningless.

As a result of these transfers and the changes of status of two of the taxa involved, there are now 14 North American species of *Gutierrezia*. *Gymnosperma glutinosum* is closely related to this group and may be transferred to *Gutierrezia* in the future; this taxonomic decision must await additional study.

1. GUTIERREZIA **conoidea** (Hemsley) Lane, comb. nov. Based on: *Xanthocephalum conoideum* Hemsley, Biol. Centr. Amer. 2: 109–112. 1882.

2. GUTIERREZIA ALAMANI Gray, Smithsonian Contr. Knowl. 3(5): 91 (Pl. Wright. 1: 91). 1850. This species has been known most recently as *Xanthocephalum linearifolium* (DC) Greenman (Publ. Field Mus. Nat. Hist. Bot. series 2: 345. 1912), based on *Keerlia linearifolia* DC (Prod. 5: 309–310. 1836). However, when placed in *Gutierrezia*, it must take Gray's epithet because of the pre-existence of *G. linearifolia* Lag. (Gen. et Sp. Nov. 30. 1816).

3. GUTIERREZIA ALAMANI Gray var. **megalocephala** (Fernald) Lane, comb. & stat. nov. Based on: *Xanthocephalum megalocephalum* Fernald,

Proc. Amer. Acad. Arts 36: 505. 1901.

4. GUTIERREZIA **sericocarpa** (Gray) Lane, comb. nov. Based on: *Xanthocephalum sericocarpum* Gray, Proc. Amer. Acad. Arts 15: 31–32. 1880.

5. GUTIERREZIA WRIGHTII Gray, Smithsonian Contr. Knowl. 5(6): 78 (Pl. Wright. 2: 78). 1883. Gray himself later transferred this species to *Xanthocephalum* (Proc. Amer. Acad. Arts 8: 632. 1873), but my work has convinced me that the original placement is more correct.

6. GUTIERREZIA **arizonica** (Gray) Lane, comb. nov. Based on: *Greenella arizonica* Gray, Proc. Amer. Acad. Arts 16: 81–82. 1880.

7. GUTIERREZIA **ramulosa** (Greene) Lane, comb. nov. Based on: *Greenella ramulosa* Greene, Pittonia 1: 302–303. 1887.

8. GUTIERREZIA SPHAEROCEPHALA Gray, Mem. Amer. Acad. Arts n.s. 4(1): 73–74 (Pl. Fendl. 73–74). 1849. This species was transferred by Shinners to *Xanthocephalum* and considered by Solbrig to be a synonym of *Gutierrezia glutinosa*, however, in my treatment it will receive specific status in *Gutierrezia.*

9. GUTIERREZIA TEXANA (DC) T. & G. var. **glutinosa** (S. Schauer) Lane, comb. & stat. nov. Based on: *Hemiachyris glutinosa* S. Schauer, Linnaea 19: 724. 1847.—*Meredith A. Lane, Department of Botany, University of Texas, Austin, TX 78712.*

HESPERALOE FUNIFERA (AGAVACEAE) IN TEXAS.—*Hesperaloe funifera* (Koch) Trelease was collected in the course of field work for a Texas Natural Area Survey of the Devil's River—Dolen Falls area in Val Verde Co. (Smith, J. M. and M. Butterwick. 1975. A Vegetational Survey of the Devil's River—Dolan Creek Area. *In* A Natural Area Survey Part VI of VIII. Division of Natural Resources and Environment, The University of Texas, Austin, Texas. Available at the Texas State Library). This species is known from northern Mexico from eastern and central Coahuila to Nuevo Leon (one station) and San Luis Potosí (several stations) (R. Engard, Desert Botanical Garden, Phoenix, pers. comm.). A small Texas population was observed in shallow limestone soils of rocky upper slopes, ca. 5 km ENE of the Finnegan Ranchhouse (29° 56′ N, 100° 55′ W). An additional individual has been transplanted at the entrance of the Finnegan ranch. *Hesperaloe funifera* with its large (to 5 cm wide and 2 m long), rigid leaves and purplish-green, glaucous flowers is easily distinguished from *H. parviflora* (Torr.) Coult. which has linear, arcuately spreading leaves (2.5 cm wide and 1.2 m long), and rosey-red to salmon colored flowers. Collection data: In rocky limestone soil at the entrance to the Finnegan Ranch (29° 56′ N, 100° 58′ W), ca 65 km NW of Del Rio, Val Verde Co., 2 Aug

1979, *Deal s.n.* (TEX-LL).—*Mary Butterwick, Bureau of Land Management, Phoenix, AZ 85017, and Jackie M. Poole, Department of Botany, University of Texas, Austin, TX 78712.*

CUCURBITA DIGITATA (CUCURBITACEAE) IN TEXAS.—A specimen of *Cucurbita*, collected during field studies for a Texas Natural Area Survey of Fresno Creek, proved to be a new state record. *Cucurbita digitata* Gray was previously known from southern New Mexico, Arizona, and SE California with Mexican localities in Sonora and Chihuahua. *Cucurbita digitata* has palmately 5-parted leaves which are narrowly and deeply lobed, a character that easily distinguishes it from the other Texas species. Collection data: Infrequent in gravelly alluvium along the banks of Fresno Creek, ca 4.0 km N of the Smith House of the Big Bend Ranch (29° 23′ 30″ N, 103° 51′ '0″ W), Presidio Co., 30 Sep 1975, *Butterwick 1726* (TEX-LL).—*Mary Butterwick, Bureau of Land Management, Phoenix, AZ 85017.*

PHYLLANTHUS POLYGONOIDES (EUPHORBIACEAE) NEW TO ARKANSAS.—On June 21, 1979, *Phyllanthus polygonoides* Nutt. was discovered 4½ miles northeast of Eureka Springs, Carroll County, Arkansas. The suffruticose plants are characterized by ascending whiplike branches clustered on a caudex, obovate leaves with acute or mucronulate tips, and fruiting calyx lobes 1.5–2.5 mm long. Hundreds of the plants were scattered in glades surrounded by oak-juniper woodlands and in an old overgrown roadbed. They were growing in exposed shallow, gravelly soil underlain by limestone.

Webster (A revision of *Phyllanthus* (Euphorbiaceae) in the Continental United States. Brittonia 22: 44–76, 1970) listed the range of *P. polygonides* as "Oklahoma and Texas south to the Mexican plateau, with outliers in New Mexico, Missouri, and Louisiana." The discovery of this station in northwest Arkansas suggests that the Missouri plants (known only from Stone County in southwest Missouri) are not disjunct but rather are at the northeast periphery of the species range which is likely continuous from Oklahoma to southwest Missouri. Dr. Edwin Smith, University of Arkansas, Fayetteville (pers. comm.) indicated to me that the flora of northwest Arkansas has been less than adequately worked and habitats similar to that described here are common in the region. Specimens (*Brooks 14254*) are on deposit at KANU, MO, NY and UARK.—*Ralph E. Brooks, University of Kansas Herbarium and State Biological Survey of Kansas, 2045 Avenue A, Campus West, Lawrence, KS 66044.*

SIDA CONTRIBUTIONS TO BOTANY

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A NEW BAHAMIAN *EUPHORBIA* AND SOME NEW COMBINATIONS

DONOVAN S. CORRELL

Fairchild Tropical Garden, Miami, Florida 33156

With the project on the Flora of the Bahamian Archipelago nearing completion we find a few loose ends that still need attention. This is one of them.

EUPHORBIA **abbreviata** Correll, sp. nov.

Frutex crassus brevis dumosus ad 70 cm altus, aliquantum cupreus, dense et grosse ramosus, ramis glabris, typice cum textura dura et rigida. Nodi annui instructi vaginis stipularibus adaxialiter ciliolatis; *internodia primaria 2–3 mm longa.* Folia opposita et solitaria, subsessilia, *carnosa*, integra, glabra, saepe ad nodos fasciculata, *globoso-orbiculata vel breviter oblongo-rectangulata vel anguste cuneato-obovata, 1–3 mm longa.* Cyathia solitaria axillaria, breviter pedunculata, circa 1 mm longa; glandes aliquantum magnae et prominentes ad cyathium proportione, sanguineae vel atrae, saepe contiguae, sine appendiculis. Capsula glabra, circa 2 mm longa, pedicello crasso circa 1 mm longo; semina lactea, levia in uno extremo acuta, circa 1.3 mm longa, ecarunculata angulis rotundatis.

Stout short bushy shrub to about 70 cm tall, somewhat copper-colored, densely and coarsely branched with the branches typically hard-tissued and rigid, glabrous. Nodes annual, provided with stipular sheaths that are ciliolate adaxially; primary internodes 2–3 mm long. Leaves opposite and solitary, subsessile, fleshy, entire, glabrous, often clustered at the nodes, globose-orbicular or shortly oblong-rectangular or narrowly cuneate-obovate, 1–3 mm long. Cyathia solitary in the axils, very shortly pedunculate, about 1 mm long; glands rather large and prominent for the cyathium, blood-red or blackish, often contiguous, without appendages. Capsule glabrous, about 2 mm long, supported by a stout pedicel about 1 mm long; seeds white, pointed at one end, smooth, about 1.3 mm long, with rounded angles, ecarunculate.

TYPE COLLECTION: Bahama Islands, Little Inagua, on sandy thinly coppiced slope about saline lake in southwest sector of island, plants 0.7 m tall, coppery-colored, August 12–16, 1975, *D. S. Correll 45998* (holotype, NY; isotypes, F, FTG, GH, IJ, K, MO, SMU).

Additional collections: Caicos Islands, Long Cay, northern end, March 7, 1911, *C.F. & C.M. Millspaugh 9237* (NY, US); Long Cay, July 28, 1930, *Paul Bartsch s. n.* (US).

Grisebach, in his Flora of British West Indies, p. 52. 1864, described *Euphorbia vaginulata* from Turks Islands, and it is to this taxon that the presently described species has previously been referred. In my explorations I have collected the rather widespread *E. vaginulata* on Grand Turks Island, throughout Great Inagua, in the Caicos Islands (Pine Cay, Providenciales),

SIDA 8(4): 317–319. 1980.

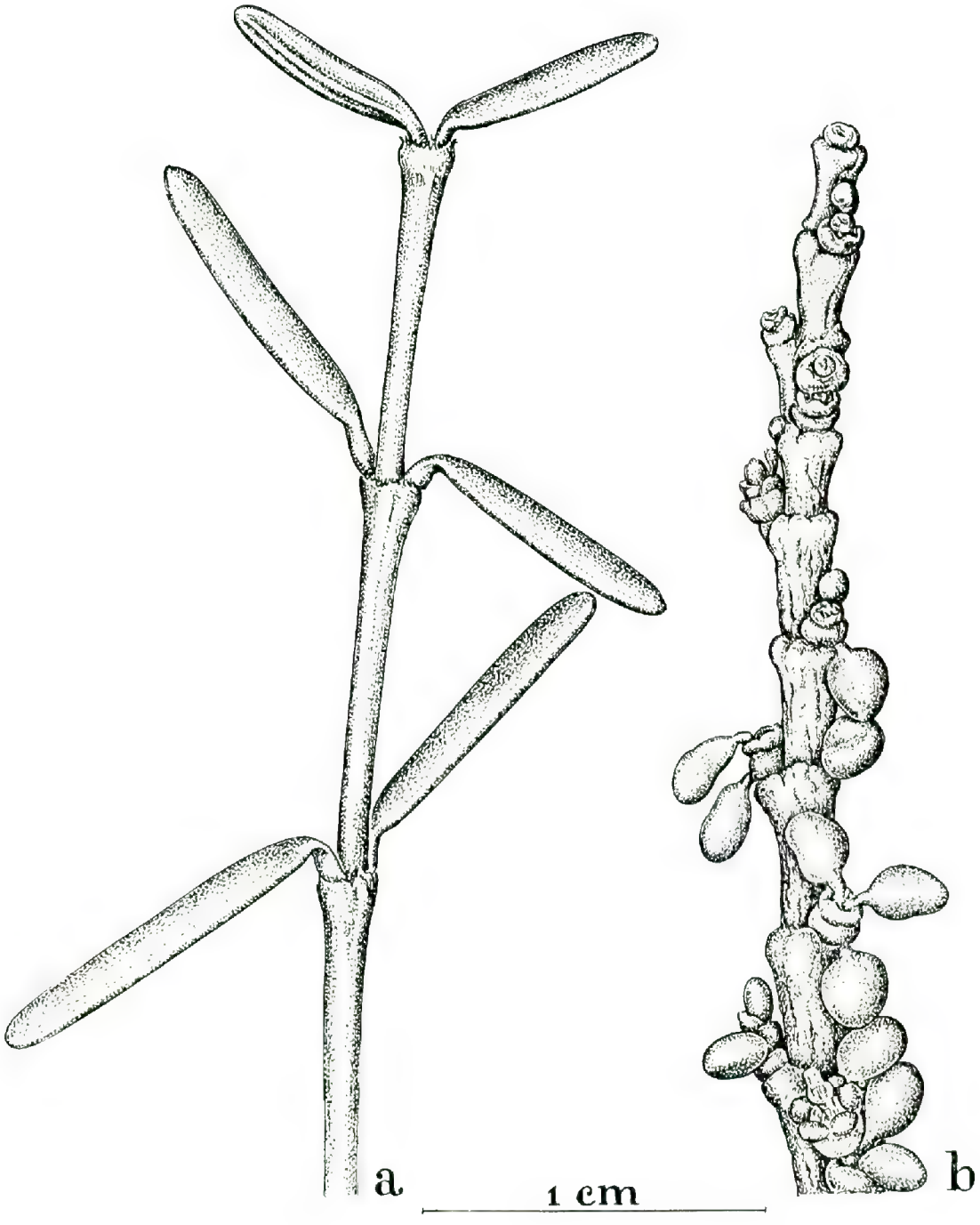

Fig. 1, a, branchlet of *Euphorbia vaginulata*; b, branchlet of *Euphorbia abbreviata*. Drawn by Priscilla Fawcett.

on Crooked Island and at its extreme northern limit on San Salvador Island. It is a rather slender plant with flexible, "rubbery" branches that produce elongate internodes and linear-oblong leaves.

The presently described species is local in its occurrence. It has a short, stout trunk from which arise rigid thick branches that have much-abbreviated internodes and suborbicular-quadrate to shortly elliptic leaves.

The following transfers are necessary for these plants to be coordinated in our Flora. They mainly represent a difference in taxonomic interpretation.

EUPHORBIA **exumensis** (Millsp.) Correll, comb. nov.

Chamaesyce exumensis Millsp., Field Mus. Bot. 2: 301. 1909.
C. lechioides var. *exumensis* (Millsp.) Burch, Ann. Missouri Bot. Gard. 53: 92, 99. 1966.

EUPHORBIA **proctorii** (Burch) Correll, comb. nov.

Chamaesyce proctorii Burch, Ann. Missouri Bot. Gard. 63: 378. 1976.

EUPHORBIA **wilsonii** (Millsp.) Correll, comb. nov.

Chamaesyce wilsonii Millsp., Field Mus. Bot. 2: 301. 1909.
C. lechioides var. *wilsonii* (Millsp.) Burch, Ann. Missouri Bot. Gard. 53: 91, 99. 1966.

CYPERUS DIFFORMIS L. (CYPERACEAE) IN NORTH AMERICA

BARNEY L. LIPSCOMB

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Dallas, TX 75275

Cyperus difformis is a widespread species of southern Europe and the tropics of the eastern hemisphere (Kükenthal, 1936; Koyama, 1961; Ohwi, 1965). It is spreading and becoming established in North America like many other oriental introductions, e.g., *C. haspan, C. iria,* and *C. rotundus.* In North America, it was first noted in México, then in the United States, and now can be reported in Nicaragua, Central America.

Early American collections and literature on the species date back to the 1850's. In his monograph on North American Cyperaceae, Torrey (1836) did not list or mention *C. difformis.* Later Torrey (1859) reported a collection (1851-1852) as *C. lateriflorus* from México. Britton (1886) noted the presence of *C. lateriflorus* in North America as being nearly allied to *C. difformis* of the old world and may be the same. Howell (1934) reported *C. difformis* in the United States from California; Fernald (1935), from Virginia. Numerous other collections have expanded the known range into Alabama, Arizona, Louisiana, North Carolina, and Oklahoma. The known distribution of *C. difformis* is given in Figure 1.

Cyperus difformis is native to the tropics of the eastern hemisphere specifically tropical and western Asia. It is a common weed in a number of habitats but most commonly found in rice paddies. The annual plant, with culms 15–60 cm tall, is similar in habit to *C. haspan* but can be distinguished from it by its subglobose spikes and obovate scales (Fig. 2). Correll & Correll (1972) has a description of the species. *C. difformis* was placed in section *Fusci* by Kükenthal (1936) and there it is most closely related to *C. fuscus* of Europe and western Asia which also has been introduced into North America.

HISTORY AND LITERATURE

The earliest known American collection of *C. difformis* is that of Charles Wright from Sonora, México, in 1851. Wright's specimen *1950* was described as a new species, *C. lateriflorus*, by Torrey (1859). Ayers (1946) did not mention the Wright specimen in his treatment of the genus in México citing only those previously cited by McGivney (1938) who cites *Wright "1960"* from "New Mexico." Wright actually collected the species in Sonora, and McGivney's citation of *"1960"* was apparently a misprint or was miscopied because the label clearly shows *1950.*

SIDA 8(4): 320–327. 1980.

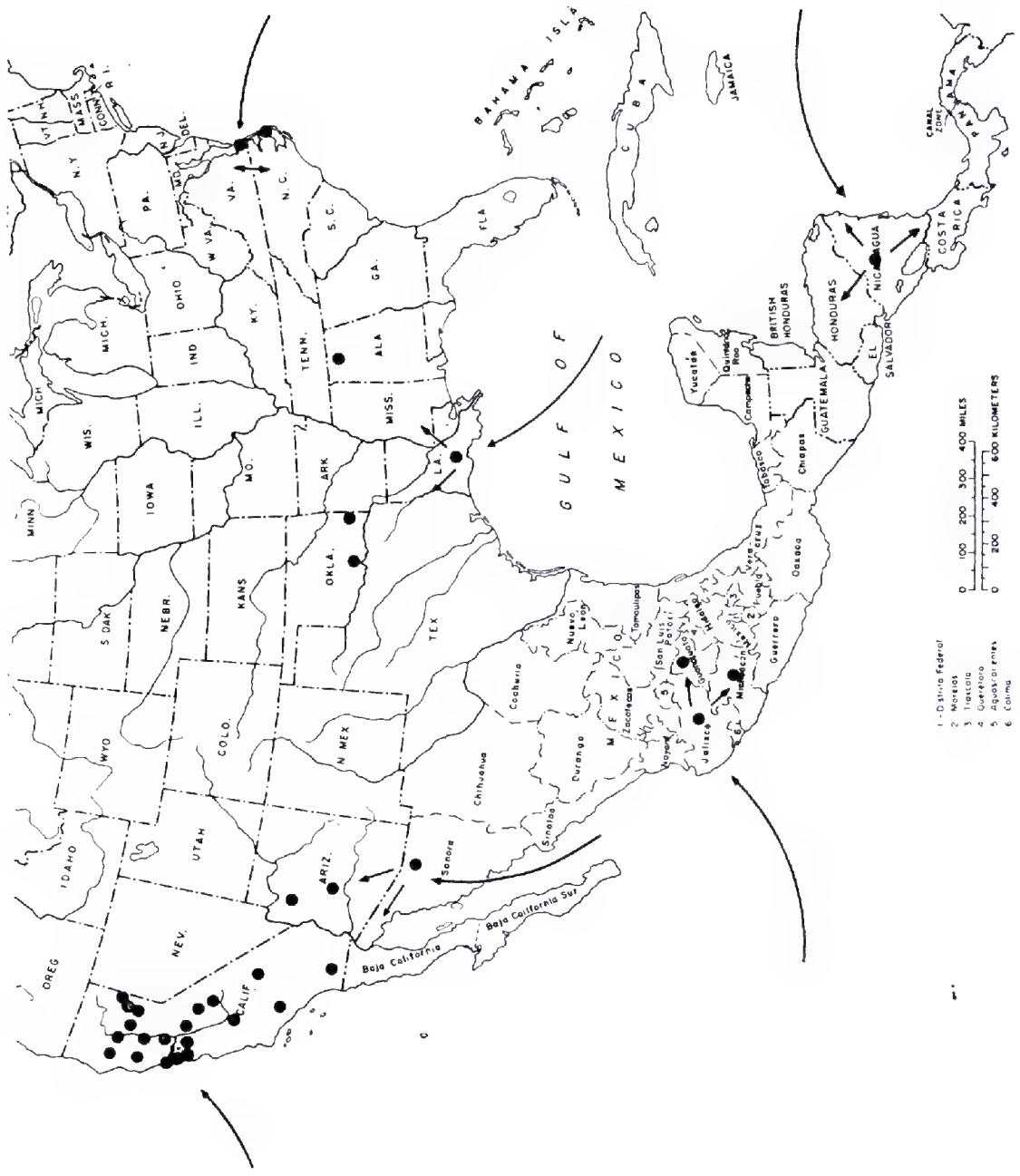

Fig. 1. Distribution of *Cyperus difformis* in North America. Long curved arrows indicate probable points of introduction and short straight arrows possible migration of the species.

Wright's collecting was done in association with the U.S. Mexican Boundary Commission in 1851. He accompanied Colonel Graham of the Topographical Engineers between 2 Sep–4 Oct on a trip from Santa Rita, New Mexico, to Santa Cruz, Sonora. During the latter part of this trip (29 Sep), Wright collected the *Cyperus* just east of Santa Cruz. Wright's (1949–52)

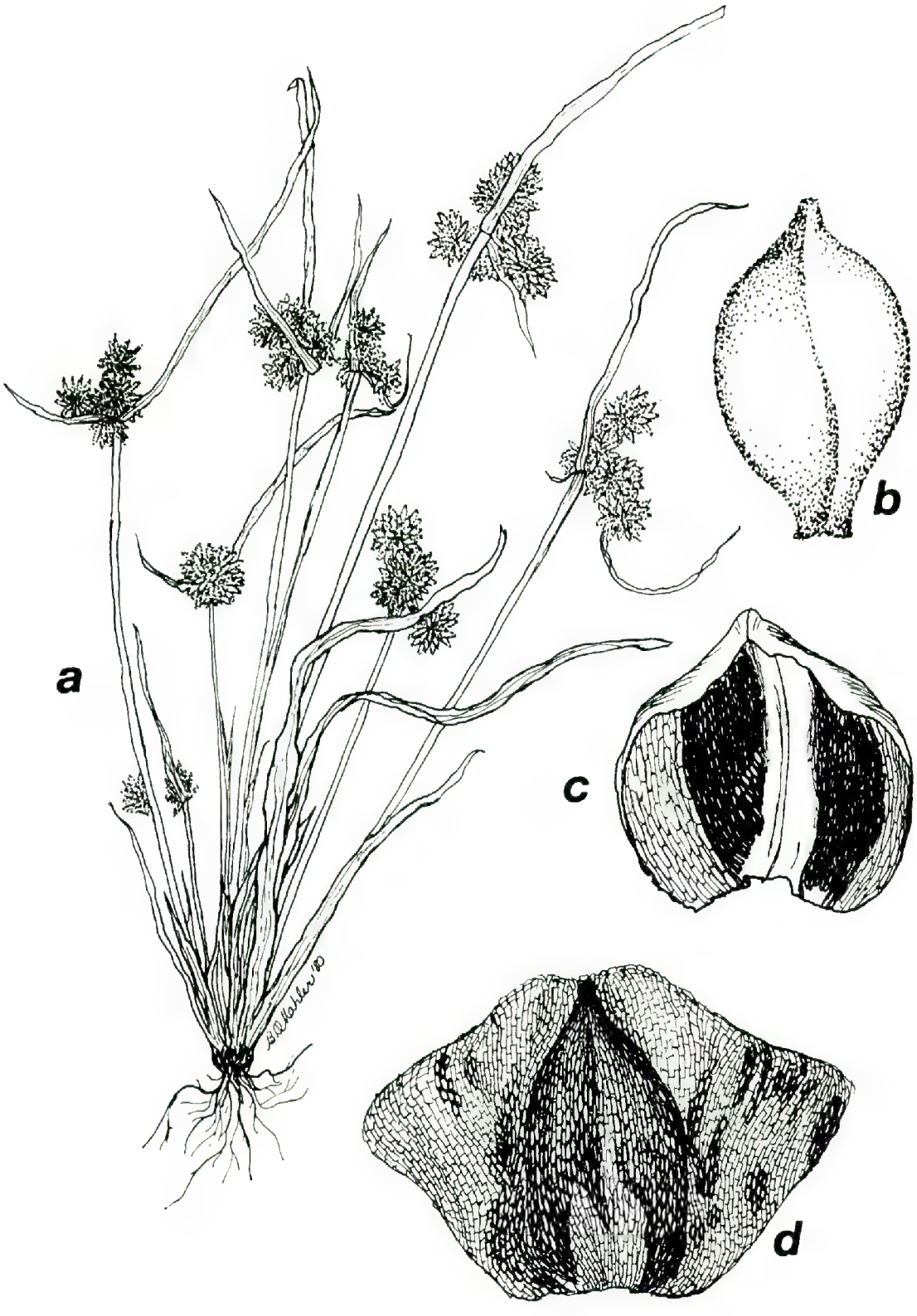

Fig. 2. *Cyperus difformis* L. A. habit. B. achene, C & D. scale (from *Delahoussaye 71.*)

field notes give the following data: along mountain torrents east of Santa Cruz, 29 Sep 1851, *Wright 674*. Wright's field number of *674* is the same as "*Wright 1950*" assigned by Gray for distribution.

Wright's collections of 1849–1852 from southwestern United States create a problem for botanist who try to work with his plants. Gray, who received and processed the specimens, sent them out under a new set of numbers and not under Wright's own field numbers. Wooton (1906) noted that the specimens of the 1851 and 1852 collections were under the same printed label and this made it difficult, if not impossible, to fix localities and exact dates of collections. Most of the printed labels do not show the habitat or exact locality and date as given in Wright's field notes (Wooton, 1906).

Since Wright's collection, additional collections of *Cyperus difformis* in 1890 and 1909 were reported by McGivney (1938) in southern México. It was 25 years later that the species was first collected in the United States. Howell (1934, 1949, 1958) first reported it from California followed by Fernald (1935) from Virginia. It was then reported from Arizona by Kearney and Peebles (1951). Additional reports from the United States are Thieret (1964) from Louisiana, Correll and Correll (1972) from Oklahoma, Tyndall et al. (1977) from North Carolina, and Godfrey and Wooton (1979) from Alabama.

INTRODUCTION AND DISTRIBUTION

The data on introduction and distribution of *Cyperus difformis* follows a chronological order based on label data taken from specimens examined. The data of the earliest collections, as well as others, does not necessarily indicate the time of introduction, establishment or the direction of migration.

Cyperus difformis was first collected on the North American continent in northern México. However, this first collection does not establish this locality and date as the time or place *C. difformis* was introduced. The earliest reference to *C. difformis* in North America was Torrey (1859). A search of earlier literature [Bentham, (1839–1857); Humboldt et al. (1815); and Kunth (1822)] yielded no mention of *C. difformis*. However, since the plant was probably present (maybe even several years) before collection, it would be reasonable to assume that the approximate time of introduction was sometime between 1815–1851. The first collection was reported by Kükenthal (1936) who cites *Wright 1950*, Santa Cruz, New Mexico. McGivney (1938) also cited it from New Mexico and it has since been erroneously reported from New Mexico in various treatments, e.g. Correll & Correll (1972), Godfrey & Wooton (1979), Kearney & Peebles (1951, 1960), and Tidestrom & Kittell (1941).

Additional specimens examined: MÉXICO: Guanajuato: 1 mi NW of Salamanca, *Waterfall & Wallis 13901* (SMU). Jalisco: near La Barca, *Pringle 3261* (ENCB). Michoacán: valley of the Lerma, *Pringle 3261* (MO); vicinity of Morelia, *Arsene*

3173 (MO); vicinity of Morelia, *Arsene 3092* (MO).

Based on herbarium specimens from México and the United States *C. difformis* appeared in the United States flora some 65 years later than México. It was first collected in California in 1915: Butte Co.: very abundant in canals, ditches, roads, and fields, Jul 1915, *Johnston W132J* (NY). Howell (1934) published the first United States report of *C. difformis* based on a 1921 collection from California: Butte Co.: weed abundant in rice fields, Nelson, 25 Nov 1921, *McLearn 15* (CAS).

Additional specimens examined: CALIFORIA: Alameda Co.: 16th Street Statin, Oakland, 8 Jul 1935, *Jussel s.n.* (CAS). Butte Co.: rice fields, 9–10 Aug 1921, *Kennedy s.n.* (UC); Sanford slough, SW corner of Butte Co., *Mason & Grant 12636* (UC); Gray Hodge Game Refuge NW of Pennington, *Mason 12737* (CAS, UC); Sacramento Outing Club, *Mason & Grant 13024* (DS, UC); rice plots, Biggs Rice Experiment Station, *Tucker 2680* (CAS, SMU, UC); eastern outskirts of Oroville, *Howell 34637* (NY). Colusa Co.: Colusa rice fields, 18 Sep 1925, *Kennedy s.n.* (UC); rice fields, *Dunshee 14* (UC); rice fields, 3 mi W of Williams, *Howell 19838* (CAS, DS, MO, NY, SMU, UC); 8 mi N of Colusa, *Mason & Grant 12983* (UC); 2 mi W of Colusa on Williams hwy., *Mason & Grant 13011* (UC); 1.6 mi W of Williams, *Mason & Grant 13116* (UC); rice field, 3 mi W of Williams, *Nobs & Smith 1877* (UC). Fresno Co.: King's River E of Burrel, *Mason & Smith 8341* (DC, UC). Glen Co.: edge of pond S of Willows Migratory Wildfowl Refuge, *Beetle 3061* (UC). Kern Co.: Tupan hwy 1/4 mi S of Adohr Rd., *Twisselmann 6580* (CAS, NY); Lake Wooloomes near Delano, *Twisselmann 8957* (CAS). Madera Co.: Crocker-Hoffman Ranch near Merced, *Wagnon 4a* (UC); San Joaquin River just E of Firebaugh, *Twisselmann 9131* (CAS). Marin Co.: Mt. Tamalpais, camp above Marin Woods, *Howell 20771* (CAS). Merced Co.: 0.5 mi S of Lake Yosemite, 27 Jul 1938, *Wagnon s.n.* (UC); Crane Ranch S of jct of Merced & San Joaquin rivers, *Mason & Smith 8328* (UC); Los Banos Bird Reserve, *Jussel 90* (CAS); San Joaquin River 0.25 mi S of hwy 152 2.9 mi E of Santa Rita Park, *Wiggins & Wiggins 20701* (DS, ENCB, NY). Nevada Co.: Wolf Creek 1 mi N of Nevada-Placer Co. line, *Nobs & Smith 1534* (UC). Plumas Co.: near Virgilia, *Howell 35064* (NY). Sacramento Co.: American River at Fair Oaks, *Crampton 1713* (CAS). San Diego Co.: Balboa Park, *Gander 8893* (DS, UC). San Francisco Co.: Lake Merced, 7 Aug 1953, *Bush s.n.* (CAS). Santa Barbara Co.: Las Positas Rd. near Fox Canyon, 12 Oct 1962, *Pollard s.n.* (CAS, ENCB); Las Positas Rd., near jct of Veronica Springs Rd., 3 Nov 1962, *Pollard s.n.* (MO, NY, SMU); 3 Nov 1963, *Pollard s.n.* (CAS). Sonoma Co.: Guerneville, *Rubtzoff 2919* (CAS). Stanislaus Co.: 4 mi S of Oakdale, *Hoover 57* (CAS); Claus, *Hoover 1628* (UC). Sutter Co.: 6.3 mi E of Knight's Landing, 6 Jul 1938, *Cantelow s.n.* (CAS); Sutter by-pass on Yuba City Knight's Landing hwy, *Mason 12705* (NY, UC); 1.7 mi S of Robbins, *Howell 50876* (NY). Tehama Co.: Pacific hwy 0.5 mi N of Butte Co. line, *Heller 14804* (MO, NY, UC). Tulare Co.: Pixley Nat. Wildlife Refuge, *Twisselmann 11590* (CAS).

KNOWN RECORDS FROM OTHER STATES

VIRGINIA. The collection of *C. difformis* from Virginia in 1934 (Fernald, 1935) is apparently the only one known from the state. This probably represents a separate and direct introduction from Asia than from the west coast. Its most probable source of introduction is in rice-straw used in packing,

as suggested by Fernald.

ARIZONA. *Cyperus difformis* was first reported as likely to occur in Arizona by Kearney & Peebles (1942). "Not known definitely to occur in Arizona but has been collected at Santa Cruz, Sonora, about 20 miles south of the international boundary." The following specimens are known from Arizona. Maricopa Co.: swamp area below dam of Lake Pleasant Regional Park, 8 Oct 1964, *Lehto 5461* (NCU). Mohave Co.: Goose Lake of Havasu Lake Refuge near Toprock, 27 Oct 1948, *Monson s.n.* (CAS). These collections probably represent introductions from México or California.

LOUISIANA. Thieret's report of *C. difformis* in Louisiana is based on the following collection: Lafayette Parish: rice field 13 mi W of Lafayette, 23 Oct 1963, *Delahoussaye 71* (SMU). Through correspondence, Thieret indicated he had later collected the species in Lafayette Parish but at a different locality: Lafayette Parish: rice fields, 2 mi NW of Indian Bayou, 10 Sep 1977, *Thieret 50236* (KNK). These collections are probably independent introductions from Asia.

OKLAHOMA. The Oklahoma report was made by Correll and Correll (1972): Leflore Co.: gravel bars along spillway of Lake Wister, 17 Sep 1970, *Correll & Correll 39765* (TEX). One additional specimen can be reported from Johnston Co.: moist soil along Blue River, 24 Sep 1977, *Puckett 36* (SMU). This specimen was a gift from Dr. Mickey Cooper of Cameron University and was collected on a class field trip through southeastern Oklahoma. The source and origin of introduction of these are questionable. It is possible that they have originated from the populations in Louisiana.

ALABAMA. Limestone Co.: bottoms of Tennessee River of Wheeler National Wildlife Refuge N of Dekatur, 22 Sep 1970, *Kral 41221* (ENCB, NCU, SMU). *C. difformis* has only recently been reported from the state by Godfrey & Wooten (1979).

NORTH CAROLINA. Dare Co.: ca 1.5 km N of Duck, along the shoreline of Currituck Sound, with *Scirpus americanus*, 2 Oct 1978 *Tyndall 791* (ODU, SMU). It was first collected 14 Oct 1974 at the same location, *Tyndall s.n.* (ODU) and has only recently been reported from North Carolina by Tnydall et al. (1977).

DISTRIBUTION IN CENTRAL AMERICA

Early studies—e.g., Clarke (1908), Hemsley (1882-1886), and Standley (1930)—do not list *C. difformis* from Central America. Hemsely's report of the species is that of *C. lateriflorus* from Sonora.

The only collection examined was collected in 1969 in Nicaragua. Matagalpa: beside pond, Rte 1, S of Dario, Calabazas, 25 Dec 1969, *Atwood 2566* (SMU). This has recently been reported from Nicaragua by Seymour (1980) as *C. haspan* with duplicates at BM, ENAG, F, GH, NY, WDP. The nearest known localities are reported in this paper and are about 1000–1100 miles to the northwest in Michoacán. It is unknown whether or not

C. difformis has become established in Nicaragua. The specimen was mature when collected and had already dropped "seed," thus probably establishing the original source or increasing the existing population.

SUMMARY AND DISCUSSION

Cyperus difformis was originally described by Linnaeus in 1756. The habitat noted by Linnaeus was in India. It is suspected and generally accepted that, by means of man, especially with the introduction of rice, *C. difformis* has spread to the new world tropics and subtropics of Central and North America. Since the introduction of it into the United States, probably around 1910–1915, it has become established through the southeast and southwest from Virginia to California. Since being introduced in California it has spread over much of the state as a weed and has become a potential problem in certain rice-growing regions.

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Thank you John Thieret for taking time to read and review this paper. Your comments and suggested changes are much appreciated. I thank the herbaria, CAS (24), DS (6), ENCB (4), KNK (1), MO (6), NCU (2), NY (12), SMU (9), and UC (24), who kindly loaned specimens. A total of 88 sheets were borrowed. The numbers in parenthesis are numbers of sheets borrowed.

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THE DISTRIBUTION OF *HABRANTHUS TUBISPATHUS* (L'Her.) TRAUB IN SOUTH AMERICA AND NORTH AMERICA— TEXAS AND LOUISIANA

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ABSTRACT

The plant known as *Habranthus texanus* (Herb.) Steud. is considered synonymous with *H. tubispathus* (L'Her.) Traub. Its distribution includes warm temperate South America and southeast Texas and northwest Louisiana. It is proposed that this species is native to South America and was introduced into the United States in the late seventeenth or early eighteenth centuries possibly by Spanish missionaries.

The plant known as *Habranthus texanus* (Herb.) Steud. is cited by Sealy (1937) as the only species of the genus to occur in the wild outside of South America. Despite being considered endemic to Texas by Correll and Johnston (1970), this plant has been reported in Louisiana as early as 1934 by Dormon. It has a long and confusing nomenclatural history. This appears to be caused, in part, by the plants of the United States never having received clear distinction from certain warm temperate South American expressions of the genus. This paper is intended to clarify the nomenclature and distribution of this interesting plant and provide information on its ecology and occurrence in the United States.

The plant, known locally as the "Copper Lily," is a scapose perennial arising from a brown ovoid bulb of about 1–2 cm in diameter. The apex of the bulb is abruptly narrowed into a tubular-like sheath composed of the remains of the leaves. The bulb bears 2–6 linear, deep green grass-like leaves that are 3–5 mm wide and up to 20–25 cm in length. Leaves normally wither prior to flowering. The scape is 10–20 cm tall and bears one flower. The bulb may flower more than once per year, occasionally possessing two scapes, each with a flower or fruit in various stages of development. Borne

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slightly beneath the flower is a tubular scarous bract ending with a bifid, long attenuated tip. The pedicel is about twice the length of the bract. The flower is 2–3 cm long, slightly zygomorphic, and inclined. Tepals are obovate with rounded apices ending in an apiculate claw-like tip, this more pronounced on the outer whorl. The perianth is bright yellow, with the outer surfaces tinged with burgundy, the color deepening toward the base. The six stamens are slightly declinate and in fascicles of four different lengths and apparently attached to the base of the perianth. At the point of attachment are scarous, lacinate enations. The style is about two-thirds the length of the corolla (about the length of the longest stamen) and ends in a trifid stigma. The inferior ovary is somewhat tubular, three-loculate, and possesses very narrow, sub-herbaceous wings that extended onto the pedicel. At maturity the fruit is ovoid, three-lobed, and contains numerous black wafer-like seeds about 3–5 mm in diameter and 0.55 mm thick.

Field observations and data from herbarium specimens indicate the Copper Lily proliferates in dryer, well-drained, but disturbed areas, of low vegetation. Maximum flowering occurs from July through October following periods of heavy rainfall. At such times it may exhibit complete aspect dominance. Sporadic, but very light flowering may occur at other times during this period. Flory (1939), in reviewing Pace's (1913) embryological work on this plant, pointed out that this was apparently the first known incidence of diploid parthenogenesis, while at the same time having a sexually produced endosperm. Crane (1978) refers to this condition as semigamy. This appears to be the common condition in the Zephyrantheae tribe of the Amaryllidaceae ("rain lillies"). It gives a special advantage in allowing self pollination without genetic penalty in this group whose erratic and unpredictable flowering may lower the chance of insect pollination (Charles Crane, pers. comm.)

The synonymy of this species reflects not only its uncertain specific status but also the close affinities that exist between *Habranthus* and *Zephyranthes*. The plant of the United States was first designated *Zephyranthes texana* by Herbert. Upon proposing the genus *Habranthus*, Herbert himself gave it varietal status as *H. andersonianus* var. *texanus*. Steudel reinstated the plant to specific status as *H. texanus*. Later, Green created the combination, *Atamasco texana*. Direct comparison of the plants of the United States (known as *Habranthus texanus*) with those of South America (part of the *H. andersonii* complex) showed no differences that warrant retention of specific status for *H. texanus*. In fact, no differences could be detected and correlated with geography to give a definite geographical race or variety worth recognizing. Our opinion is that the name *H. texanus* rests solely on its disjunct distribution rather than an actual morphological distinction. This point of view is shared by Sealy (1937), Alexander (1939), and Ravenna (1970). Ravenna also showed that the type of *H. andersonii* (of which *H. texanus* is here considered synonymous) is identical to the type of *H. tubispathus* (L'Her.) Traub, the basionym being *Amaryllis tubispatha*.

Therefore, the correct name for the only *Habranthus* outside of cultivation in the United States is *H. tubispathus*. Complete synonymy is as follows:

Habranthus tubispathus (L'Her.) Traub, Plant Life 7: 42. 1951.
Amaryllis tubispatha L'Her., Sert. Angl. 9. 1769.
Zephyranthes texana Herb., Curtis Bot. Mag. London, 3482. 1836.
Habranthus andersonianus Herb., Amary. 167. 1837.
Habranthus andersonianus var. *texanus, l.c.*
Zephyranthes commersoniana Herb., *l.c.*, tabl 29, f. 3.
Habranthus texanus (Herb.) Steud., Norm. ed. 2 (1): 717. 1838.
Zephyranthes andersonii (Herb.) Steud., Nom. Bot. ed. II. 1. 70. 1840.
Amaryllis andersonii (Herb.) Griseb., Goett. Abhandl. 24: 320. 1879.
Zephyranthes andersonii (Herb.) Bentham & Hooker f., Gen. Pl. 3(2): 724. 1883.
Zephyranthes andersonii (Herb.) Baker, Handbook Amaryll. 37. 1888.
Atamasco texana Green, Pittonia 3: 187. 1897.
Atamasco tubispatha G. M., Rev. Fac. Let. & Cienc. 19: 227. 1914.

The distribution of the species includes southern Brasil, Uruguay, Argentina,, central and southern Chile, and the United States (east Texas and northwest Louisiana). The species has, under various of the synonyms cited above, been reported in much of the Antilles and northern South America (see Pulle, 1966; Grisebach, 1864; Adams, 1972; Moscoso, 1943; and Urban, 1903). However, the plant of those areas has a white flower and is referable to *Zephyranthes puertoricensis* Traub.

Herbaria abbreviations follow that of Index Herbariorum (ed. 6). except for Institute for Botanical Exploration (IBE), Mississippi State, Mississippi.

Specimens examined: NORTH AMERICA: United States: Texas. Anderson Co.: Wilcox, near Palestine 1 Aug 1943, *Barkley s.n.* (TEX); Bastrop Co.: Texas Hwy. 71 on the first knoll E of Garfield, 5 Oct 1966, *Mears 1017* (TEX); Bexar Co.: San Antonio, Oct 1850, *Thurber s.n.* (F); Brazos Co.: College Station, 7 Sep 1969, *Frywell 1108* (SMU); Caldwell Co.: 4.65 mi N of Lockhart on Texas Hwy. 183, 6 Aug 1966, *Mears 680* (TEX); Calhoun Co.: Port Lavaca, *Gentry 46* (F); Colorado Co.: Eagle Lake, Oct 1930, *Biology Class s.n.* (TEX); Comal Co.: New Braunfels, Oct 1850, *Lindheimer 1207* (F, SMU); DeWitt Co.: without further location, 18 Jul 1942, *Riedel s.n.* (TEX); Fayette Co.: Muldoon, 20 Jul 1950, *Ripple 51-713A* (TEX); Jim Wells Co.: 15.2 mi S of Alice, 13 Sep 1955, *Johnston 2781A* (SMU); Gonzales Co.: 4.5 mi S of Belmont, 27 Sep 1958, *Correll 20466* (LL); Karnes Co.: Karnes City, 29 Aug 1953, *Johnson 1302* (SMU); McLennan Co.: M-K-T RR N of Gapshead, Jul 1946, *Smith 56* (TEX); Milam Co.: U.S. Hwy. 190, ca 10 mi NE of Cameron, 26 Oct 1963, *Henderson 63-1833* (SMU, TEX); Nacogdoches Co.: E. Austin St., Nacogdoches, 7 Jul 1955, *Lacey 32* (SMU); San Patrico Co.: ca 4 mi NW of Sinton, 24 Oct 1948, *Rogers 6643* (TEX); Travis Co.: 19 mi S of Victoria, *Cory 45965* (TEX); Waller Co.: Hempstead, 10 Jun 1872, *Hall 654* (F); Williamson Co.: 2 mi SW of Georgetown, 2 Oct 1944, *Wolcott 217* (TEX); Walker Co.: Near Huntsville, Jun 1914, *Young s.n.* (TEX); Louisiana. Caddo Parish: Columbia Park, Shreveport, 31 Jul 1977, *MacRoberts 262* (LSUS); Natchitoches Parish: Los Adaes, 1 mi E of Robeline, 18 Sep 1978, *Holmes 3346* (IBE, NATC); Sabine Parish: ca 3/4 mi W of Natchitoches-Sabine Parish line on La. Hwy 6, 18 Sep 1978, *Holmes 3344* (IBE, NATC). SOUTH AMERICA. Argentina. Buenos Aires. La Casada, *Troucoso 1296* (F); Brasil: Minas Gerais. Serra de Piedade, Caete, 11 Nov 1938, *Barreto 8809* (F); *Chile*: Cordillera de Chile, 1(90,

Hanenke 2122 (F); Paraguay: Cordillera de Altor, Mar 1903, *Fiebrig 1017* (F); Uruguay. Montevideo. Sayago, 5 Jan 1930, *Herter 85498* (F) and *85494* (F); Atahualpa, Dec 1925, *Herter 79892* (F) and *79891* (F).

Since the plant formerly known as *Habranthus texanus* is considered synonymous with *H. tubispathus*, it is doubtful it is native to both southern South America and Texas and Louisiana. Several points make it probable that the plant is native to southern South America and its disjunct distribution of well over 10,000 kilometers is better explained in another way. These include the following:

1. Most other species of *Habranthus* (ca 23, Ravenna, 1970) are native to South America, which undoubtedly is the center of distribution for the genus. Two species have, since 1937, been described from Mexico.
2. Although plants morphologically identical to the plants of the United States exist, considerably more variation is present in the South American populations of this species. The variation is well documented by Ravenna (1970) who proposed several infraspecific names based on flower size and minor color differences. If introduced into the United States, it would almost certainly have come from one population and not exhibit the total range of variation present in the species (Founders Principle). This coupled with its parthenogenic habit would explain and insure a great amount of morphological uniformity. Examination of herbarium specimens, field observations, and cultivation support this argument.
3. The plants of the United States inhabit disturbed places of low, usually grassy vegetation (lawns, roadsides, railroads, etc.).
4. The plant is very abundant in west-central Louisiana only in the areas settled or developed at the same time Texas was being settled by the Spanish. These include the City of Natchitoches, founded in 1714, and the El Camino Real (now roughly following Louisiana Highway 6) a trail marked in the early 1700's connecting Natchitoches with Spanish Texas, and thence to Mexico. It was also extremely abundant at Los Adaes, the easternmost Spanish mission founded in 1717, which is 15 miles west of Natchitoches on the El Camino Real, 30 miles from the Texas state line. It is also abundant on Highway 6, westward from Los Adaes for about five miles. The plant has not been reported from any other place in Louisiana, other than Shreveport (Caddo Parrish) where it is believed a recent introduction that is still quite rare, even though the habitat appears favorable. The occurrence of this plant in these, the oldest inhabitated areas of Louisiana, and with the close ties that existed with Spanish Texas, (also being settled at the same time) apparently indicates that it may have been introduced into Louisiana in the same manner and at the same time as it appears it was introduced in Texas.

In considering the possible ways in which *Habranthus tubispathus* could be introduced into the United States, natural methods can probably be discounted because the plant does not appear to possess either long or moderate range dispersal mechanisms, either by seed or other vegetative structure. The plant does not appear to possess a vegetative means of reproduction, other than bulbs, which appear unlikely to be transported by natural means. Transport by a "dirty bird" also seems unlikely considering the dry habitat of the plant and sporatic flowering and fruiting. Even if the seeds were to be utilized for food by birds, the nature of the seed is such that survival through the digestive tract seems doubtful.

The introduction of *Habranthus tubispathus* appears best explained by human activity. This was first proposed by Sealy (1937) at the suggestion of H. H. Hume of the University of Florida. He proposed that Spanish missionaries transported the plant between 1690 and 1703 during the establishment of the various missions in Texas. It should be noted, as pointed out by Flory (1938), that the only records available concerning the establishment of Spanish missions in Texas cite that they were founded by Spaniards coming out of Mexico and *H. texanus* (*H. tubispathus*) has not been reported in that country. This would certainly preclude chance introduction from Mexico, but not intentional introduction if the plant were cultivated there and could not become naturalized due to unfavorable conditions. The plant's slow rate of spread favors intentional human transport. Documented in Natchitoches some 50 years ago, and probably being present there for a much greater period of time, the plant has failed to spread outside of the city, as cited above. When its distribution area in the United States of well over 125,000 square miles is considered, it is obvious that either the plant arrived here much earlier than the Europeans (which we feel the evidence does not support), or was a direct, intentional introduction as an ornamental or possibly for some other use not known today. In no other way could the plant have spread to occupy its present distribution area. We suggest it was brought into Texas from South America, possibly via Mexico. Once established at one site, it was carried to other settlements. Under favorable conditions it escaped, became established, which further hastened its spread. These we feel are the only conditions that explain the plants' present distribution in the United States. It appears to be only a matter of time before the plant spreads to other favorable habitats in Louisiana and possibly the southeast United States.

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THE MIGRATION AND ESTABLISHMENT OF *JUNCUS GERARDII* (JUNCACEAE) IN THE INTERIOR OF NORTH AMERICA

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Juncus gerardii Loisel (Juncaceae), a member of the rush family occurs along the Atlantic and Pacific coasts of North America and locally inland on the continent. On the Atlantic coast, the plant is often a dominant member of the upper littoral zone where it may form extensive stands in salt marsh meadows at the upper limit of ordinary tides (Nichols, 1920). Apparently once confined to the coastal salt marshes, *J. gerardii* has evidently migrated inland where it has been reported from ten midwestern and Great Lakes states and the provinces of Manitoba and Ontario in the past 120 years. More recently it has invaded Colorado and Utah in western United States. This paper presents the documentation for the migration and establishment of *J. gerardii* as isolated occurrences in the interior of North America. The progressive range extension over a period of approximately 120 years and the present known North American distribution of *J. gerardii* based on herbarium data and published accounts are mapped in figure 1.

Although a true rush, *J. gerardii* is commonly called black grass. Other common names that have been applied to the species are given in Table 1. In earlier North American scientific literature, the species was reported under the name *J. bulbosus* L.

EAST COAST DISTRIBUTION AND EARLY OCCURRENCES IN THE INTERIOR

In eastern North America, the apparent native distribution of *J. gerardii* is in the Atlantic coastal salt marshes. Its range is usually stated as extending from Newfoundland, Quebec, Nova Scotia, New Brunswick, the coastal states of the United States to Virginia and sometimes to Florida. I have verified herbarium specimens of its coastal range from Newfoundland to Virginia. However, the southern limit of its Atlantic coastal range is not clear from the literature. In his classic revision of the North American species of *Juncus*, Engelmann (1866) reported the southern limit of *J. gerardii* as North Carolina and Florida and cited as authorities, Curtis and Ware, respectively. This range to Florida has been repeated by Fassett (1940), Fernald (1950), Muenscher (1944), Small (1933), Wiegand (1900), and mapped by Hultén (1958). However, its range is given as far south as Virginia in Gleason (1952), Gleason and Cronquist (1963),

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TABLE 1.

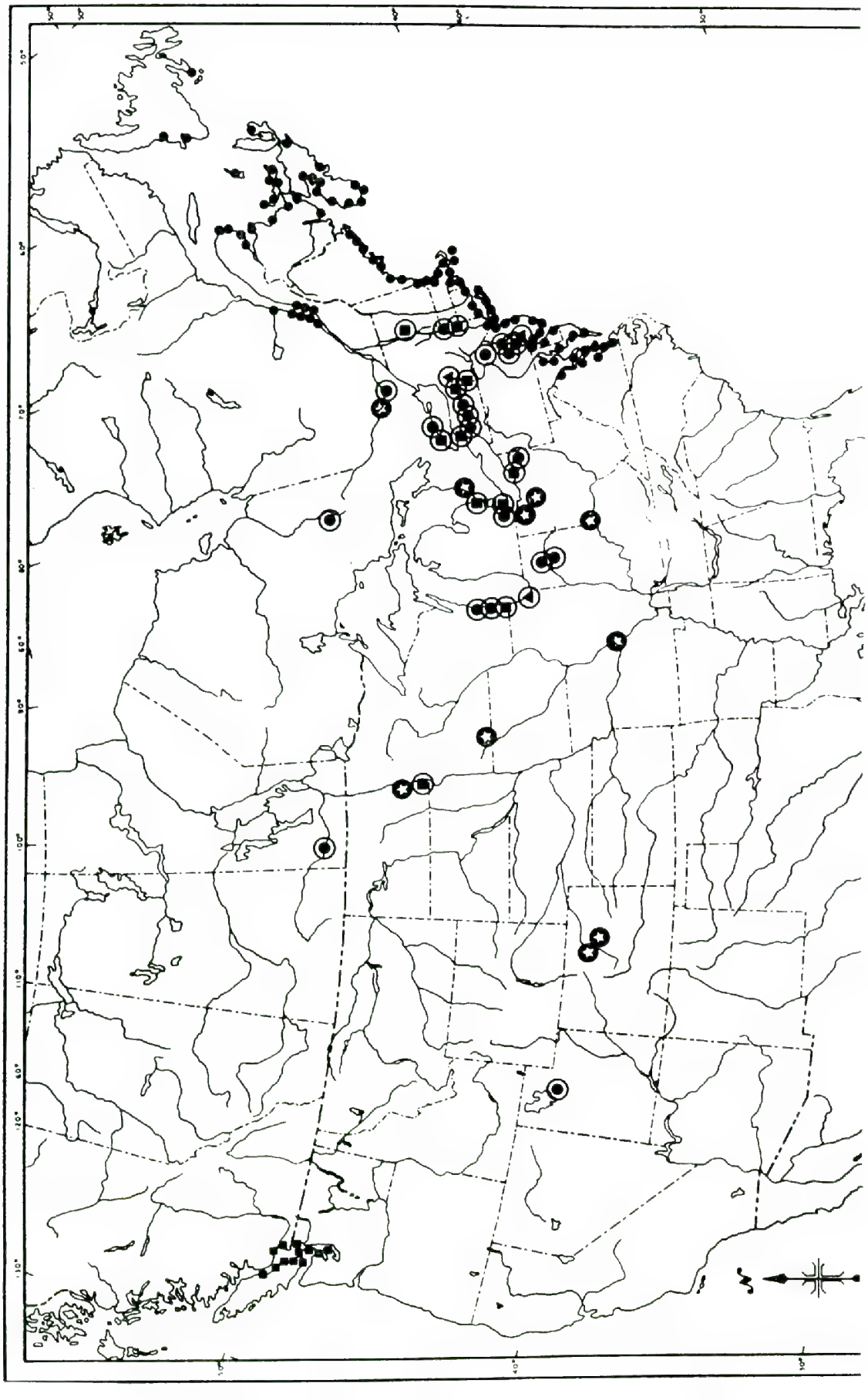
COMMON NAMES OF *Juncus gerardii* LOISEL OTHER THAN BLACK GRASS

COMMON NAME	REGION OF THE UNITED STATES WHERE USED	REFERENCES
Black-grass Rush	Florida	Ward (1968)
Gerard's Rush	New York;	Hanmer (1940);
	Ohio	Schaffner (1914, 1932)
Hog-rush	Southeastern United States	Small (1933)
Nut grass	Maryland	McAtee (1933)
Salt-marsh Rush	New England	Seymour (1969a)
Saltmeadow Rush	British Columbia	Taylor and MacBryde (1977)

and only as far south as Delaware by Potter (1932). It is not reported for the Carolinas by Radford, Ahles, and Bell (1968) or from North Carolina by Beal (1977), but is listed for Florida by Ward (1968). According to Eleuterius (1976), *J. gerardii* is replaced by *J. roemerianus* beginning in New Jersey and extending southward in the east coastal salt marshes to Florida and on the Gulf Coastal Plain to Texas.

What is believed to be the earliest record of occurrence of *J. gerardii* inland in the United States appears in the *North American Botany* by Eaton and Wright (1840), where they reported the species for Michigan. No specimen has been located to verify this record. A second inland occurrence in the Great Lakes region was reported as "near Chicago . . . *Dr. Vasey*," by Engelmann (1866). This second record was apparently based on specimens obtained in 1862 in vacant lots at Chicago, Illinois, by George Vasey (GH, US). Vasey's specimens substantiate the statement in the 5th edition of Gray's *Manual* that *J. gerardii* was "rare along the Great Lakes" (Gray, 1867). The previous edition of the *Manual* noted that the species was "common along the coast from New Jersey northward" with no mention of locations in the interior on the continent (Gray, 1863). Gray's statement in the 5th edition of the *Manual* served as the basis for the record cited in three early catalogues of the flora of Michigan (Wheeler and Smith, 1881; Beal and Wheeler, 1892; Beal, 1905), rather than the citation of the record in Eaton and Wright (1840).

The beginning of the inland spread of *J. gerardii* is documented in New Jersey and Pennsylvania where the species was first reported as "Not frequent" from a specimen obtained in 1866 on ballast ground at Petty's Island



near Philadelphia in the Delaware River (Smith, 1867). Herbarium specimens (MO, PENN, PH, US) from ballast habitats in Camden and Philadelphia date from 1863 to 1876 and document this early introduction. The species has spread northward into Leigh, Montgomery, and Northampton Counties, Pennsylvania, where it its known from alluvial flats and wet meadows along railroads, as documented by specimens dating from 1924 into the 1960's (PENN, PH). Schaeffer (1949) reported that the populations in Northampton County "probably represent plants which were introduced by salt hay."

ESTABLISHMENT IN THE MIDWESTERN AND GREAT LAKES STATES

Expansion of the range of *J. gerardii* in New York evidently came in the mid-to late-nineteenth century. Torrey (1824) gave its distribution in that state as "common in the vicinity of New-York," and later Torrey (1843) wrote "Borders of creeks and ditches in salt marshes: common on Long Island and Staten Island." Gray (1863) in the 4th edition of his *Manual* noted its distribution as "Salt marshes; common along the coast from New Jersey northward." However, in the 5th edition, Gray (1867) first noted it as "also in saline marshes of W. New York." This apparent range extension was probably based on the specimens obtained in 1864 and 1865 at Salina, Onondago County, by George W. Clinton (MO, PH) which also was the basis for the citation in Engelmann's revision (1866). In a catalogue of plants of that vicinity, Paine (1865) noted *J. gerardii* from "Rivuletsides and wet banks, east of Salina and west of Onondaga Lake, in thick patches. Common there." Twenty years later, the species was listed as "sparingly, on the brackish marshes E. of Montezuma" in the Cayuga Lake Basin in western New York (Dudley, 1886). In central New York, additional locations are known from Fall Creek, Myers Point, the Union Springs (Wiegand and Eames, 1926), at Silver Springs near Gainesville in Wyoming County, and at Greigsville near York in Livingston County (Zenkert, 1934). At the Silver Springs locality, *J. gerardii* was noted on 30 August 1926 as common in a number of places along Wolf Creek where salt and brine from the Remington Salt Factory was being dumped into the stream (Muenscher, 1927a, b). Additional localities in central and

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Figure 1. Distribution of *Juncus gerardii* in North America, with emphasis on its spread into the interior of the continent. Large symbols show locations of cited specimen records and periods of time they were obtained, according to the following key: Triangles in circles (1860–1884), squares in circles (1885–1919), dots in circles (1920–1949), stars in circles (1950–1979). Small symbols indicate the general range of the species along the coast. Dots show the apparent native range along the east coast; squares show the range on the west coast. In addition to herbarium records, the east coast range is derived from maps by Erskine (1960), Hultén (1958), Potter (1932), Roland (1945), and Rousseau (1974).

western New York include Hamburg, Ithaca, Lansing, McLean, Piffard, Retsof, Springport, and Syracuse, as derived from the list of cited specimens. The species has apparently spread in the man-created saline habitats of central and western New York, although some writers have doubted its being non-indigenous to the area (Wiegand and Eames, 1926). A century later, *J. gerardii* continues to persist in Onondago County, the same county where it was initially discovered in the interior of the state of New York (Faust, 1961). In the eastern part of the state, the species has been located on rocks in the bed of Kinderhook Creek at Stuyuesant Falls in Columbia County (McVaugh, 1958) and in moist depressions on dredgings from the Hudson River at Rensselaer (BH, CU) indicating that it had moved inland along the Hudson River in the 1930's.

In Ohio, *J. gerardii* has always been considered native, including the most recent treatment by Braun (1967), although she allowed that the species was "perhaps introduced along railroad tracks." First recorded by Beardslee (1874) as "rare" from "Lake [Erie] Shore," this record was repeated by Kellerman and Werner (1893). The earliest known specimens are those obtained in 1891 and 1895 at Cleveland by Edo Claassen (OS), which served as the basis for the record in his Cuyahoga County list of plants (Claassen, 1895). These Cuyahoga County specimens also served as the basis for Schaffner's only record in his two catalogs of Ohio vascular plants (Schaffner, 1914, 1932). A second record was taken 34 years later at Phalanx in Trumbull County by Almon N. Rood (OS). The plants were "abundant in low, wet swale," but were erroneously reported as *J. greenei* (Schaffner, 1933), and later corrected (Schaffner, 1935). Additional specimens obtained by Rood in 1936 were labeled as "Phlanax Station, wet swale by R.R.," supporting the hypothesis that the species had probably invaded via the railway. More recent records have come from along a railroad at Crestline in Crawford County by Floyd Bartley (OS) and from a ditch at the International Salt Company at the mouth of the Cuyahoga River in Cuyahoga County by Allison Cusick (KE).

The only known specimens of *J. gerardii* for Michigan are those obtained by C. K. Dodge in 1911 and 1915 at Port Huron in St. Clair County and by O. A. Farwell in 1931 and 1932 at Wayne in Wayne County (Voss, 1972). The 1911 specimens came from railroad yards. The 1931 plants were from wet ditches, and as reported by Farwell (1941) were then believed to be the first record for Michigan. Voss (1972) has stated that this species is "quite probably not indigenous in Michigan."

In Indiana, Peattie (1930) first reported *J. gerardii* as very rare from brackish wet sand in Indiana Harbor, Lake County, but attempts to locate a specimen from this locality have been unsuccessful. In 1935, however, the species was first found to be well established on dry open ground along the Nickle Plate Railroad four miles east of Kokomo, Howard County by C. M. Ek (Hermann, 1938, 1940). In 1942, the species was obtained farther

north in the next county, Miami County, along the Pennsylvania Railroad, three miles west of Bunker Hill by C. M. Ek (GH, MO).

Vassey's record of *J. gerardii* from near Chicago has long been disputed. Jones and Fuller (1955) excluded it from the flora of Illinois, because the species was "not attributed to Illinois, or indeed even mentioned, in any of Vasey's published reports on the flora of Illinois, . . ." Their conclusion was accepted until more recent studies have verified its occurrence in the Chicago area, based on specimens collected in 1900 and 1956 (DeFilipps, 1964, 1966; Mohlenbrock, 1970; Swink, 1969, 1974).

KNOWN RECORDS FROM OTHER STATES

VERMONT: First reported "on the margin of a marshy meadow very near the railway station at New Haven Junction: where it was believed to have been imported in "saltmarsh hay often used in packing" (Eggleston, 1904). Not reported earlier in the flora of Vermont (Brainerd, Jones and Eggleston, 1900), nor in the most recent flora of Vermont (Seymour, 1969b).

WISCONSIN: Reported from near railroad yards in Milwaukee and Sheboygan Counties (McIntosh, 1950), based on specimens obtained in the 1930's, and in Racine County as early as 1900 (Swink, 1969, 1974). The most recent specimen, taken in 1977, is from a wet area along railroad tracks in Fox Point, Milwaukee County (OSH).

MINNESOTA: Stated by Hultén (1958) as a weed along railways in Minnesota, with a mapped location in the southern part of the state evidently based on the record from Martin County obtained in 1950. The species is also cited for Clay and Kittson Counties (McGregor and Barkley, 1977) based on records from the 1960's. The specimen from Clay County is *J. alpinus* (shoulder of roadside ditch, Muskoda, 8 Jul 1960, *O. A. Stevens 2231*, DAO, US), and the specimen from Kittson County is *J. compressus* (roadside at Caribou, 28 Jun 1962, *J. W. Moore 26083*, TRT).

NORTH DAKOTA: Listed for Cass and Richland Counties (Stevens, 1961; McGregor and Barkley, 1977). The record from the latter county is dated 1908.

MISSOURI: Observed during the years 1964 through 1966 in the southern part of the Ranken yard of the Terminal Railroad Association, east of Compton Avenue, in St. Louis (Muehlenbach, 1969).

KENTUCKY: Obtained in 1978. This specimen is the most recently known record and is from a population of plants in diesel sludge mud of railroad yard near tracks, near junction of West 19th Street and Augusta Street, Covington, Kenton County (OS).

Selected Specimens: ILLINOIS: [Cook Co.]: Vacant lots, Chicago, 1862, *Vasey s.n.* (GH, US); railroad and roadside, Chicago, 1956, *Glassman 3788* (CHI, ILLS, NP). INDIANA: Howard Co.: Railroad, Kokomo, 1935, *Ek s.n.* (GH, IND), 1936, *Deam 57045* (NY). Miami Co.: Railroad, Bunker Hill, 1942, *Ek s.n.* (GH, MO). KENTUCKY: Kenton Co.: Railroad yard, Covington, 1978, *Applegarth 465* (OS). MICHI-

GAN: [St. Clair Co.]: Railroad freight yards, Tunnel Station, 1911, *Dodge s.n.*, (MICH); damp ground, Port Huron, 1915, *Dodge s.n.* (US). [Wayne Co.]: Ditches, Wayne 1931, *Farwell s.n.* (GH), *Farwell 8897* (MICH). MINNESOTA: Martin Co.: Railroad, Fairmont, 1950, *Moore 20689* (GH, MIN). MISSOURI: St. Louis Co.: Railroad, St. Louis, 1964, *Muehlenbach 2356* (MO, US); 1965, *Muehlenbach 2505, 2522, 2476* (MO); 1966, *Muehlenbach 2625* (MO). NEW JERSEY: [Camden Co.]: Camden, 1863, *Canby s.n.* (MO): ballast. Petty's Island in Delaware River, 1866, *Burk s.n.* (MO), *Diffenbach s.n.* (MO, PH), *Parker s.n.* (GH, MO, PH); ballast, Kaighns Point, 1876, *Martindale s.n.* (PH, US). NEW YORK: Cayuga Co.: Brackish meadow east of Salt Creek, Montezuma, 1885, *Dudley s.n.* (CU); brackish place by railroad station, Union Springs, Springport, 1919, *Eames & Wiegand 11730* (CU, GH); salty meadows, Montezuma, 1919, *Wiegand, Randolph, & Eames 11729* (CU). Columbia Co.: Bank of creek, Stuyvesant Falls, 1933, *McVaugh 997* (NY, PENN); rocks in Kinder Creek, Stuyvesant Falls, 1945, *McVaugh 3126* (CU). Erie Co.: Meadow, Hamburg, 1939, *Glowenke 3868* (PENN). Livingston Co.: Ditches along roadside, salt factory, Piffard, 1926, *Muenscher 16495* (CU, GH); stream bank, salt factory, Retsof, 1926, *Muenscher 16495* (CU). [Onondaga Co.]: Salina, 1864, *Clinton s.n.* (MO), 1865 (PH); salt marshes, Syracuse, 1880, *Sheldon 2973* (US); salt marshes, Onondaga Lake, 1883, *Habertr 954* (CAN, US), *s.n.* (MO). Rensselaer Co.: Moist depressions in dredgings Hudson River, Rensselaer, 1939, *House 27070* (BH, CU). Tompkins Co.: Railroad, Myers, Lansing, 1918, *Eames 9559* (CU, GH); railroad ditch, McLean, 1920, *Wiegand & Muenscher 13448* (CU, GH). Wyoming Co.: Salt marsh, Silver Springs, 1926, *Muenscher & Burkholder 16498* (CU, GH). NORTH DAKOTA: Cass Co.: Railroad, Fargo, 1954, *Stevens 1497* (DAO, NY, US). Richland Co.: Sandy soil, Colfax, 1908, *Ball 694* (US). OHIO: Crawford Co.: Railroad, Crestline, 1960, *Bartley s.n.* (NY, OS). Cuyahoga Co.: Cleveland, 1891, 1895, *Claassen s.n.* (OS); ditch, International Salt Company, mouth of Cuyahoga River, Cleveland, 1974, *Cusick 13723* (KS). Trumbull Co.: Wet swale, Phalanx Station, 1925, *Rood s.n.* (OS); wet swale, railroad, Phalanx Station, 1936, *Rood 1077* (KS, NY, PENN). PENNSYLVANIA: Lackawanna Co.: Roadside ditch, Carbondale, 1946, *Glowenke 6812* (GH, PENN). Leigh Co.: Railroad, Laury's Station, 1924, *Pretz 12155* (PH); meadow, Allentown, 1960, *Schaeffer 6095* (PH). Montgomery Co.: Railroad, Hatboro, 1943, *Long 59871* (PH). Northampton Co.: Meadow, Butztown, 1946, *Schaeffer 22738* (PH); railroad, Northampton, 1947, *Schaffer 25947* (PH); shore, Siegried, 1961, *Schaeffer 63226* (PH). [Philadelphia Co.]: Ballast ground below the navy yard, Philadelphia, 1866, *Parker s.n.* (MO, PH). VERMONT: [Addison Co.]: Railroad, New Haven Junction, 1897, *Brainerd s.n.* (GH). WISCONSIN: [Racine Co.]: Lake beach, Racine habor, 1900, *Wadmond 2740* (CU, MIN, WIS). Milwaukee Co.: Railroad Estabrook Park, Shorewood, 1939, *Shinners 1069* (PENN, WIS); railroad, Fox Point, 1977, *Harriman 14125* (OSH). Sheboygan Co.: Railroad yard, Sheboygan, 1933, *Goessl s.n.* (WIS).

DISTRIBUTION IN THE INTERIOR OF CANADA

In Canada, *J. gerardii* was early reported by Macoun (1888) from only coastal marshes in Nova Scotia, New Brunswick, Quebec, and Vancouver Island. In the interior of Canada, in Ontario, *J. gerardii* was not included among the introduced plants of that province (Montgomery, 1956). However, the species has been known from the province as early as 1903, based on specimens obtained by William Scott (CAN, CU, DAO, TRT) from a railroad roundhouse at Niagra Falls. *J. gerardii* has been located in Ontario at other isolated sites along railways, usually at stations were salt has been

sprinkled to melt snow in the winter. The most recent records seen are from 1974, 1975, and 1976, (CAN, DAO, TRT). In the Toronto region, Catling and McKay (1975) have described the plant communities at two saline sites, one a salt storage depot on the west side of the Don River near the Bloor Street viaduct and the other a snow dumping site on landfill at the foot of Leslie Street, where *J. gerardii* is plentiful with other halophytes. Boivin (1952) reported the species as a weed along railway embankments at Cochrane and Hope in Ontario and at Brandon in Manitoba.

Selected Specimens: MANITOBA: Weed along railway embankments, Brandon (cited by Boivin, 1952). ONTARIO: Carleton Co.: Slightly saline soil, at Mississippi River bridge east of Arnprior, 27 miles west of Ottawa, 1959, *Dore & Cody 17425* (MSC); river, Rockcliff Park, Ottawa, 1947, *Calder, Dore, & Cody 1641* (MO). [Cochrane Co.]: Railway yards, Cochrane, 1952. *Baldwin 3912* (CAN, GH). Durham Co.: Abandoned railway, Hope Township, 1948, *Reeve 87* (DAO). Essex Co.: 1913, *Malte s.n.* (CAN); dry open saline ground, Windsor Salt Factory, Windsor, 1975, *Catling & McKay s.n.* (CAN, TRT). Huron Co.: Saline soil, south side of Maitland River, below Sifto Salt brine operation, Goderich, 1975, *Catling & McKay s.n.* (CAN, TRT). Welland Co.: Railroad roundhouse, Niagra Falls, 1903, *Scott s.n.* (CAN, CU, DAO, TRT); Montrose railway yard, Niagra Falls, 1976, *Catling & McIntosh s.n.* (DAO, TRT); ditch between two rail embankments, Bertie Township, Niagra, 1976, *Catling & Riley s.n.* (DAO, TRT). York Co.: Dump heap, Ashbridge's Bay, Toronto, 1904, *Scott s.n.* (CU, TRT); wet depression receiving run off from rock salt storage depot, opposite Don Valley Brickyard, Don Valley, Toronto, 1974, *Catling & McKay s.n.* (CAN, TRT); in snow dumping area, foot of Leslie Street, Toronto, 1974, *Catling & McKay s.n.* (TRT).

DISTRIBUTION IN WESTERN NORTH AMERICA

On the west coast, *J. gerardii* is known from the coastal salt marshes in the Puget Sound area in the state of Washington, on Vancouver Island, and in southern British Columbia. Some question has been raised as to whether or not the species is native there because the morphology of the plants more closely resemble those from Europe, whence they may have been introduced at an early date (Hitchcock, Cronquist, and Ownbey, 1969). The species was first reported from salt marshes at Victoria, Vancouver Island by Macoun (1838), based on his collection of 26 Jun 1887 (GH). However, the species was not included in the *Flora of Washington* by Piper (1906). The earliest known specimen from Washington is dated 1917 and comes from Lopez on San Juan Island where it was obtained by S. M. and Mrs. E. B. Zeller (GH). Additional records were added in the 1920's and 1930's. Muenscher (1941) wrote the *J. gerardii* was local in salt marshes and cited two localities, South Bellingham and Marietta in Whatcom County. St. John (1928) considered the plants on the west coast as a native species and proposed the name *J. fucensis*.

Inland in the Rocky Mountains of western United States, *J. gerardii* has been located in two states:

COLORADO: Known from wetlands at one site in Adams County and two locations in Boulder County, as reported by Hermann (1975). The earliest record is from the latter county, dated 1952.
UTAH: Reported as "Introduced and established in salt marshes near Salt Lake City" (Tidestrom, 1925). This record is apparently based on a specimen from a salt grass pasture near Salt Lake City (Jun 1922, *G. Q. Bateman s.n.*, US). The species was not included in the *Intermountain Flora* by Cronquist (1977).

SOME GENERAL CONSIDERATIONS AND CORRECTIONS

It has become apparent that the spread of *J. gerardii* inland into the Great Lakes region and midwestern United States has come about by either migration of the species via railroads or by establishment in inland saline marshes, as documented in the above specimen citations and summarized in Table 2. Of the 58 known inland stations east of the Great Plains, 26 of them (44%) are from along railroads and 13 of them (22%) are from inland saline habitats in New York, Ohio, and Ontario. Most, if not all, of the inland saline habitats cited here have been artificially created since the coming of European man. Other significant localities are man-made roadside ditches and ballast ground, which account for the habitat at eight localities (14%). The occurrence in isolated sites and especially in man-created habitats which account for 80% of the known localities, strongly suggests that *J. gerardii* is a non-indigenous member of the wetland flora of the Great Lakes region, mid-western, and certain western areas in the United States. Furthermore, the occurrence of *J. gerardii* in the Finger Lakes region of New York, for example, conforms to Svenson's idea that human agencies have been perhaps the most effective means of distributing these halophytic species into that region, rather than surviving as remnants from a post-Pleistocene marine submergence (Svenson, 1927).

As pointed out by Eggleston (1904) in Vermont and by Schaeffer (1949) in Pennsylvania, *J. gerardii* has been transported as a salt hay in packing. In Massachusetts, Deane (1915) noted that black grass was cut in the summer and fall and used for packing on celery beds to keep the stocks from freezing during the winter. The plants also can form "balls" or "pebbles" from matted sods which are thrown upon beaches during ditching operations (Ganong, 1905). These sods are rolled about, worn down, and rounded by action of the waves and may even be transported.

Potter (1932, 1934) cited *J. gerardii* as an example of a halophytic species whose distribution supported the idea of a post-Pleistocene marine connection between Hudson Bay and the St. Lawrence River basin. Those species which he used as evidence occurred in the southern region of Hudson Bay at James Bay, were disjunct to the Gulf of St. Lawrence, and then ranged southward along the Atlantic coast. *J. gerardii*, however, showed certain irregularities by having isolated occurrences in the Finger Lakes region of

TABLE 2.

SUMMARY OF INLAND HABITAT TYPES OF *J. gerardii* IN RELATION TO THE NUMBER OF LOCALITIES IN THE MIDWESTERN AND GREAT LAKES STATES AND IN MANITOBA AND ONTARIO.

HABITAT	NUMBER OF LOCALITIES	PERCENTAGE OF TOTAL NUMBER OF LOCALITIES
Railroad	26	44
Salt marsh; saline or brackish marsh	13	22
Roadside ditch	4	7
Ballast ground and dredgings	4	7
Other habitats	11	20
Total	58	100%

New York, at the southern end of Lake Michigan, and on the Pacific coast. This irregularity has now been explained. Earlier, Peattie (1922) had correctly omitted *J. gerardii* as an example of a natural member of the Atlantic Coastal Plain element in the Great Lakes region. Moreover, as reported and mapped by Rousseau (1974), *J. gerardii* is not known at James Bay, and he has stated that Potter's specimen at the Gray Herbarium is *J. alpinus*, as determined by L. Cinq-Mars. The report from a James Bay by Macoun (1888), which Rousseau could not verify, apparently is from a local James Bay at Vancouver Island, British Columbia. Macoun's published report is clear, "Salt marsh at the head of James Bay, Victoria, Vancouver Island, 1887. (*Macoun.*)," and agrees with the date on the label of his specimen (24 June 1887, *Macoun 27,869*, CAN).

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NOTES ON THE FLORA OF THE CHINATI MOUNTAINS, PRESIDIO COUNTY, TEXAS

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The first definite records of botanical observations in the Chinati Mountains are those of V. Havard (1885). G. C. Nealley (1888) collected grasses and forage plants and made general observations in western Texas, visiting the "Chenate" Mountains in late October, 1887. M. S. Young made general collections in the foothills of the Chinatis in September, 1914, but probably never reached the main mass of the mountains (Tharp 1962). The most extensive botanical explorations of the Chinatis were begun by L. C. Hinckley in August, 1936. Collecting trips were made to Chinati Peak in 1945 by C. H. Muller and Rogers McVaugh. B. H. Warnock began working in the area both alone and with Hinckley during the 1940's; specimens from these and subsequent trips are deposited at TEX-LL and SRSC herbaria.

The present authors made collecting trips into the area in June and October of 1977. Voucher specimens will be deposited in the University of Texas at Austin Herbaria (TEX-LL). Nomenclature for species previously reported from Texas is in accordance with Correll and Johnston (1970).

The rugged summits of the Chinati Mountains rise over 1400 m above the surrounding pediments, dominating the 30 km expanse between Pinto Canyon and Shafter in south central Presidio Co. The Chinati Mountains are one of three major mountain ranges in the Big Bend area of Trans-Pecos Texas that are of igneous origin, the others being the Chisos and Davis Mountains. The considerable erosive force of tributaries to the Rio Grande, such as Pinto and Dead Horse canyons, has uncovered various sedimentary rocks of Permian and Cretaceous age. These localized outcrops of limestone, sandstone, and shale, primarily along the margins of the intrusive and volcanic rocks, are the substrates for plant assemblages that are noticeably different from those found on neighboring igneous slopes.

On the limestone hills just N of Chinati Peak, associated with *Agave lecheguilla, Dasylirion leiophyllum, Quercus pungens, Mortonia scabrella, Leucophyllum frutescens, Ayenia pilosa,* and *Bouteloua ramosa,* we found two species of particular interest.

SIDA 8(4): 348–351. 1980.

POLYGALA NUDATA Brand. On limestone hills N of Chinati Peak between Dead Horse and Pinto Canyons; *Butterwick 3807B*; 9 Jun 1977. This is the fourth known United States locality for this perennial *Polygala*, which until recently has been placed in synonymy with the Mexican *P. minutifolia* Rose (Wendt, 1978). *Polygala nudata* is characterized by its upright broom-like incurved-puberulous stems and short seed pubescence.

PETERIA SCOPARIA Gray. Infrequent on limestone hills N of Chinati Peak; *Butterwick & Lott 3829*; 11 Jun 1977. This species is previously unreported from the Chinatis but its presence there could be expected. It is poorly represented in herbaria and generally occurs in small, scattered populations.

Indian Cave Canyon, a side canyon to Dead Horse Canyon, on the N side of the Chinatis, provides a sheltered, more mesic habitat for *Prunus serotina, Fraxinus cuspidata, F. arizonica, Quercus gambelii, Q. grisea, Symphoricarpos* sp., *Heuchera rubescens, Aquilegia* sp., and *Pericome caudata* in its upper reaches, which lead to Chinati Peak. In this canyon we collected a species of fern reported for the first time from the Chinatis.

POLYPODIUM THYSSANOLEPIS Kl. Uncommon in crevices of cliffs and boulders, lower Indian Cave Canyon, with *Garrya ovata, Selaginella rupincola, Bommeria hispida, Eupatorium rothrockii, Ungnadia speciosa, Silene laciniata, Sedum wrightii,* and *Cheilanthes wrightii; Butterwick & Lott 3897*; 16 Oct 1977. According to T. L. Wendt,[1] who is preparing a treatment of Chihuahuan Desert *Polypodium*, this collection is of an undescribed variety of the southwestern United States and northern Mexico. It was previously known in Texas only from the Davis and Chisos Mountains.

The summit of Chinati Peak is surprisingly level, resembling a high mesa top. *Stipa tenuissima* occurs beneath the numerous gray oaks, and *Bouteloua gracilis* covers the more open areas. *Sedum wrightii, Talinum parviflorum, Heuchera rubescens, Aletes acaulis,* and *Triodanis biflora* are a few herbaceous species collected on or near the peak.

OPUNTIA POLYACANTHA Haw. var. TRICHOPHORA (Engelm. & Bigel.) Coult. Locally common among grasses on the summit of Chinati Peak; *A. M. Powell et al. 3109*; 7 Jun 1977. This collection represents the southernmost known population of this widespread species, which ranges as far north as Peace River, Alberta. The variety occurs in Trans-Pecos Texas and the Panhandle, to Colorado and Arizona through western Oklahoma.

GAURA HEXANDRA Gomez Ortega subsp. GRACILIS (Woot. & Standl.) Raven & Gregory. Rare in rocky igneous soils near summit of Chinati Peak, ca 2313 m elev; *Butterwick & Lott 3774*; 7 Jun 1977. Scarlet flowers, reddish stems with white spreading hairs, and truncate fruit bases distinguish this species, a new state record for Texas and an extension of its range

[1] The undescribed variety of *Polypodium* mentioned above is now published as *P. thyssanolepis* Kl. var. *riograndense* Wendt (Amer. Fern J. 70: 5–11. 1980).

from Arizona and New Mexico to Sonora, Chihuahua, and Durango, and now to western Texas.

Two large canyons on the S side of the Chinati Mountains yielded noteworthy collections. Both are relatively closed drainages whose walls provide some protection from the southwesterly winds. Of particular interest was Tinaja Prieta (Palillos) Canyon, with its numerous tinajas and seep springs.

PLUMBAGO SCANDENS L. On low gravelly terrace of lower Tinaja Prieta Canyon, just above falls, and throughout the upper reaches of the canyon; *Butterwick & Lott 3872*; 16 Jun 1977. The range in Texas is now extended from Cameron and Hidalgo counties in extreme southern Texas. Known also from Pima Co., southern Arizona, and from northern Mexico and southern Florida, this species is widespread in the tropical Americas.

SIPHONOGLOSSA LONGIFLORA (Torr.) A. Gray. Rare among boulders in lower part of E branch of San Antonio Canyon, S side of Chinati Mountains; *Butterwick & Lott 3864B*; 15 Jun 1977. The essentially glabrous *S. longiflora* has petioled leaves and clusters of white tubular flowers in the upper axils which easily distinguish it from the coarsely pubescent *S. pilosella*. The Chinati Mountains locality for this species extends its range eastward from southern Arizona and Sonora and is apparently the first documented report of the species from Texas. This species is not included in the *Manual of the vascular plants of Texas* (Correll & Johnston 1970), nor are any previous Texas collections on deposit in TEX-LL, SRSC or GH. Rickett (1970) cited the species as "reported in western Texas" but stated that he had seen no specimens of it from Texas.

ACKNOWLEDGMENTS

We thank P. H. Raven for determination of the *Gaura* specimen and T. L. Wendt for his verification of our pteridophyte and *Polygala* determinations. J. Henrickson helped locate specimens of *Siphonoglossa longiflora*, and R. A. Hilsenbeck verified our determination and graciously provided useful information on this species. We are grateful to A. M. Powell for reviewing the manuscript, and to D. E. Deal for arranging permission with the landowners. Texas Natural Area Survey is gratefully acknowledged for financial and logistical support of field work in the area.

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NOTES

DISTRIBUTION RECORDS FOR *DIGITARIA BICORNIS* IN EASTERN UNITED STATES—Henrard's *Monograph of the genus Digitaria* (1950) restricted the distribution of *Digitaria bicornis* (Lam.) R. & S., tropical crabgrass, to tropical Asia. Swallen (1963) described *D. diversiflora*, a later synonym of *D. bicornis*, based on type material from Jamaica and gave the distribution in the United States as Florida and Texas. Gould (1975) reported *D. bicornis* in Texas as occurring in the southeastern prairies and coastal marshes. Correll & Johnston (1970) stated that *D. diversiflora* (i.e., *D. bicornis*) is probably indigenous to and is common on the Rio Grande Plains.

Recent collections of *D. bicornis* I have made in eastern United States have shown that this taxon is much more widespread than previously belived. It was found to be common and abundant on the sandy coastal plain of the southeastern states. The range of the species is now known to include eastern North and South Carolina, and eastern Texas (Fig. 1). The distribution of this species seems to be limited to areas of coarse-textured soils and moderate to high rainfall. Populations of *D. bicornis* and *D. ciliaris* (Retz.) Koeler, southern crabgrass, frequently grow intermingled, which possibly accounts for *D. bicornis* being frequently mistaken for the latter, better-known species. Morphological distinctions between *D. ciliaris* and *D. bicornis* are given by Gould (1975).

Voucher specimens (TAES) of *D. bicornis* were collected at locations in six states from which the species has not previously been reported: North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana. This crabgrass was found to be an important invading species of cultivated soils throughout the southeastern coastal plain. Specimens were not collected north of North Carolina; however, there seems to be no environmental reason why this species should not occur in sandy coastal areas of Virginia and Maryland. Texas collections I have made extended the range of *D. bicornis* into the pineywoods and post oak savanna vegetational regions of the eastern portion of that state. The northernmost collection site in Texas was only 30 miles from the Arkansas border and 60 miles from the Oklahoma border; future collections may extend the range of the species north into Arkansas and Oklahoma.—*Robert D. Webster, Department of Range Science, Texas A&M University, College Station, TX 77843.*

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Figure 1. Distribution of *Digitaria bicornis* in southeastern United States.

HENRARD, J. T. 1950. Monograph of the genus *Digitaria.* Leyden, Universitare Per Leiden. 999 pp.

SWALLEN, J. R. 1963. New species of *Digitaria* and *Trichachne.* Rhodora 65: 355–357.

NAJAS MARINA: NEW TO THE INDIANA FLORA—On a recent plant collecting trip through the Midwest, two collections were made of *Najas marina* L., the prickly naiad, in northeastern Indiana. After consulting the herbaria at IND and ND (acronyms follow Holmgren & Keuken, 1974), I have determined that this species is new to the Indiana flora. Collecting data for *N. marina* in Indiana are as follows: Steuben Co., off hwy 120 near I-69 at Green's Lake, ca 7 mi N of Angola, 20 Jul 1979, *Davenport 1424*; Noble Co., on hwy 3 at W side of Cree Lake, S of South Milford, 20 Jul 1979, *Davenport 1427*. Voucher specimens for both collections are deposited at UNA.

In North America, *Najas marina* is found infrequently in brackish or highly alkaline waters of the western United States, Texas, the Great Lakes states, and Florida (Haynes, 1979). Whether it is a native or a naturalized species is under question. After studying its distributional history, Wentz & Stuckey (1971) concluded that *N. marina* was introduced into the Ohio region, and fairly recent collections in Michigan (Near & Belcher, 1974), Wisconsin (Ross & Calhoun, 1951), and Illinois (Winterringer, 1966) seem to bear out this conclusion. Its occurrence in Indiana, therefore, is to be expected and indicates the further spread of this species in the Great Lakes region.—*L. J. Davenport, Ecology and Systematics Section, Department of Biology, The University of Alabama, University, AL 35486.*

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GAURA ODORATA LAG. (ONAGRACEAE) IN LOUISIANA.—Specimens from a small population of *Gaura* found in Lafayette were identified through the keys of Munz (1965) and Correll and Johnston (1970). Comparison with specimens borrowed from SMU confirms identification as *Gaura odorata* Lag., which can now be recorded from Louisiana. Lafayette Parish: rhizomatous perennial growing aggressively with *Cynodon dactylon* on uncemented square around telephone pole in parking lot on N. University Ave. near corner of Louise St., Lafayette, *Vincent 2310* (LAF), 18 Jun 1979.

The plants were observed to flower and produce fruit sporadically from March to October 1979 in spite of several mowings. They were vigorously producing new shoots in March 1980 and thus may persist and disperse in the area. Their presence in Lafayette marks a significant eastward range extension for the species, a native of Texas and adjacent Mexico that is rare in east Texas. Previously unreported from Louisiana, *G. odorata* was not included in the preliminary report on Louisiana Onagraceae by Ellis and UrBatsch (1979).

Duplicates are being sent to AC, GA, NCU, NLU, NO, SMU, and VDB.

I thank Dr. William F. Mahler for the loan of specimens.—*Karl A. Vincent, University of Southwestern Louisiana, Lafayette, LA 70504.*

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A NOTE ON FLOWER COLOR OF *WAHLENBERGIA LINARIOIDES* (LAM.) A. DC. IN NORTHWEST FLORIDA—A recent article by D. B. Ward (Phytologia 39: 1–12, 1978) includes a key for distinguishing the two known species of *Wahlenbergia* which occur within the state of Florida: *W. marginata* (Thunb.) A. DC. and *W. linarioides* (Lam.) A. DC. The key was adapted and expanded from a previous key and descriptions presented in an article by R. K. Godfrey (SIDA 1: 185, 1963). In both of these papers the flower color of *W. linarioides* is stated as blue.

During more than ten years of botanizing in the Pensacola area I have encountered *W. linarioides* at numerous sites along roadsides and in sandy pinewoods. All of the observed specimens have had white flowers. I have recently discussed this with R. K. Godfrey, and he, too, has seen primarily white-flowered specimens of *W. linarioides* in recent years. I conclude that current populations of *W. linarioides* in northwest Florida are predominantly white-flowered, and that if blue-flowered individuals exist they are rare indeed.

The fact that *W. linarioides* has white flowers makes it easy to distinguish in the field from *W. marginata*, which has blue flowers, and botanists collecting in northwest Florida should take note of this. The following white-flowered specimens of *W. linarioides* may be examined in the herbaria indicated: *Burkhalter 3908* (UWFP), *6374* (UWFP, CAS).—*James R. Burkhalter, University of West Florida, Pensacola, FL 32504.*

BRACHYELETRUM ERECTUM AND *TALINUM RUGOSPERMUM*, NEW SPECIES TO TEXAS AND NOTES ON *SCHOENOLIRION WRIGHTII*—The grass *Brachyeletrum erectum* (Schreb.) Beauv. is generally distributed throughout the eastern United States, including Oklahoma and Louisiana (Hitchcock, 1950; Gleason, 1968). It is not surprising therefore, that it occurs in eastern Texas. *Brachyeletrum erectum* was initially found in 1971 (*McCrary 171* ASTC) and has since been collected from the same location (*Kyle 40*, Jun 1976 ASTC; *Nixon 8723*, Aug 1978 ASTC). Generally this species occurs in dry to moist wooded areas. We

found it within Nacogdoches County along a branch of Naconiche Creek about 15 miles northeast of Nacogdoches, Texas. Several small populations were present. It was within a forest dominated by *Fagus grandifolia*, *Carpinus caroliniana* and *Liquidambar styraciflua* (Nixon and Raines, 1976).

Talinum rugospermum Holz. was collected from the extreme northern portion of Nacogdoches County along FM 1087 (*Nixon 7752*, Aug 1977 ASTC; *Nixon* and *Marietta 9492*, Jul 1979 ASTC). The species occurred occasionally in open, rather disturbed areas, on deep sandy soils. The reported distribution of *T. rugospermum* was the north central United States—Ia., Minn., Wis., Ill., and Ind. (Rickett, 1969; Gleason, 1968). It grows in sandy soils or on sandstone in that area. It is somewhat amazing, therefore, that this species is encountered so far south.

Schoenolirion wrightii Sherman (*S. texanum* (Scheele) Gray; Sherman, 1979) is a rare small white-flowered species that grows on moist prairies in Arkansas, Alabama, and East Texas (Hardin, Austin, Brazos, and Walker counties). It has been proposed as an endangered species (U.S. Dept. of the Interior, 1976) and was last collected in Texas in 1963 in Walker County (*Sherman 560*, 15 Apr 1963 VDB). *Schoenolirion wrightii* was collected in Apr 1978 (*Marietta* and *Nixon 61* ASCT) in an open prairie like area in Jasper County. This collection extends the known range of *S. wrightii* somewhat and verifies its present existence in East Texas.—*Elray S. Nixon and Kay L. Marietta, Biology Department, Stephen F. Austin State University, Nacogdoches, TX 75961; Michael McCrary, National Plant Materials Center, Beltsville, MD 20705.*

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HOLOSTEUM UMBELLATUM (CARYOPHYLLACEAE) IN ONTARIO.—The spread of *Holosteum umbellatum* L., jagged chickweed, in the United States has been discussed by Shinners (1965). This species, evidently native to Europe and/or western Asia, is now found throughout the United States, but the colonies tend to be widely separated and in some

cases not long persistent. It is most common in the warmer regions, and records from Michigan and New England remain few.

The only recent collections of *H. umbellatum* from Canada have been from southwestern British Columbia (Scoggan, 1978). Campbell (1895) reported having found *H. umbellatum* at Kettle Point, Lambton County, Ontario, in 1894. This record, if correct, represented a considerable westward expansion of the known range of *H. umbellatum* in North America at the time (see quotations in Shinners 1965). Later authors, however, have found no specimens documenting this report and have cited it with a question mark (e.g., Scoggan 1978) or omitted it. Specimens from Campbell's herbarium, including many from Kettle Point, are in MTMG, but, according to information kindly provided by Marcia J. Waterway, there is no specimen among them now or formerly identified as *H. umbellatum*, either under *Holosteum* or in a genus that might likely have been confused with *Holosteum* (other Alsinoideae; *Androsace*). It seems probable, therefore, that this report was erroneous, and that the specimen was reidentified soon thereafter, especially if, as the title of Campbell's paper impies, the plants in question flowered in summer. (*Holosteum umbellatum* is in mature fruit by mid-spring, and the remains of the plants disappear in summer.) There have been no other reports of *H. umbellatum* from eastern Canada.

Flowering stems of *H. umbellatum* were brought to me for identification on 18 April 1980 by J. A. Runnells of Stoney Creek, Ontario. On 23 April, following Mr. Runnells' directions, I found a population of *H. umbellatum* comprising thousands of plants along the Canadian National tracks near the Royal Botanical Gardens' Rock Garden in Hamilton, Hamilton-Wentworth Region (43° 17′ 17″ N, 79° 53′ 32″ W). Here the railroad runs through a cut in a sandbar of Lake Iroquois age, with *H. umbellatum* growing on a sunny south-facing slope of the cut, in dry sandy soil, intermixed with *Bromus tectorum* (*Pringle 1936*, DAO, HAM, OAC, MO). On 5 May 1980, I found numerous plants of *H. umbellatum* in Burlington, Halton Region, growing as weeds in crushed-stone walks in the R.B.G.'s Hendrie Park (43° 17′ 30″ N, 79° 52′ 30″ W, 1.48 km ENE of the Hamilton population), on nearly level terrain, in full sun, associated with *Erophila verna* and *Sedum acre* (*Pringle 1937*, HAM). Some plants were also found in nearby lawns where the soil is gravelly, derived from Lake Iroquois beach deposits (*Pringle 1938*, CAN, HAM, UWO).

Holosteum umbellatum can readily be distinguished from related plants of the subfamily Alsinoideae by its umbellate inflorescences and by its petals, which are jaggedly few-toothed at the apex but not regularly bifid. Following Walters' (1964) treatment of *Holosteum*, these Ontario populations represent *H. umbellatum* ssp. *umbellatum*.—*James S. Pringle, Royal*

SIDA 8(4): 357. 1980.

Botanical Gardens, Box 399, Hamilton, Ontario, Canada L8N 3H8. (Contribution No. 40 from the R.B.G.)

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